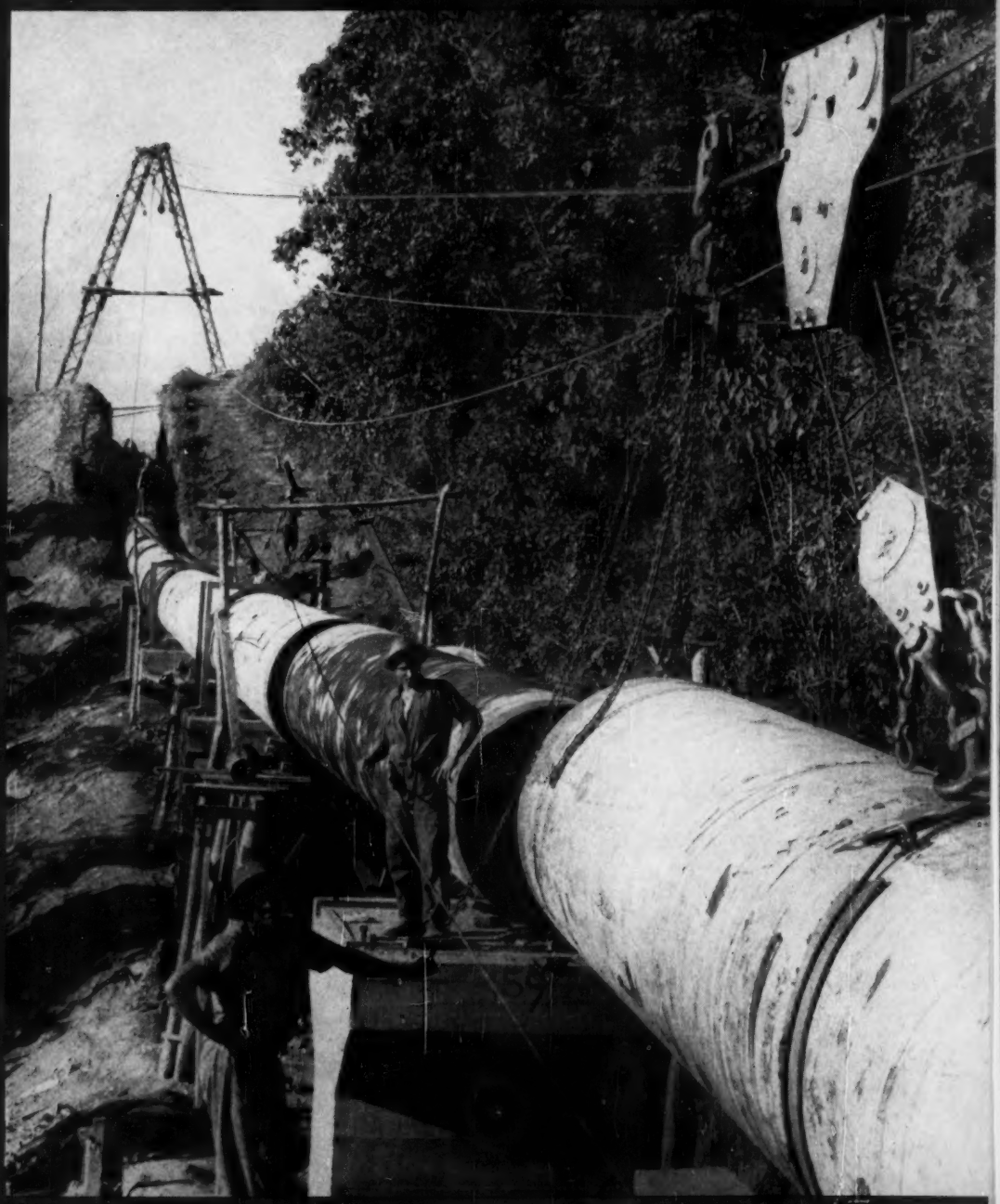
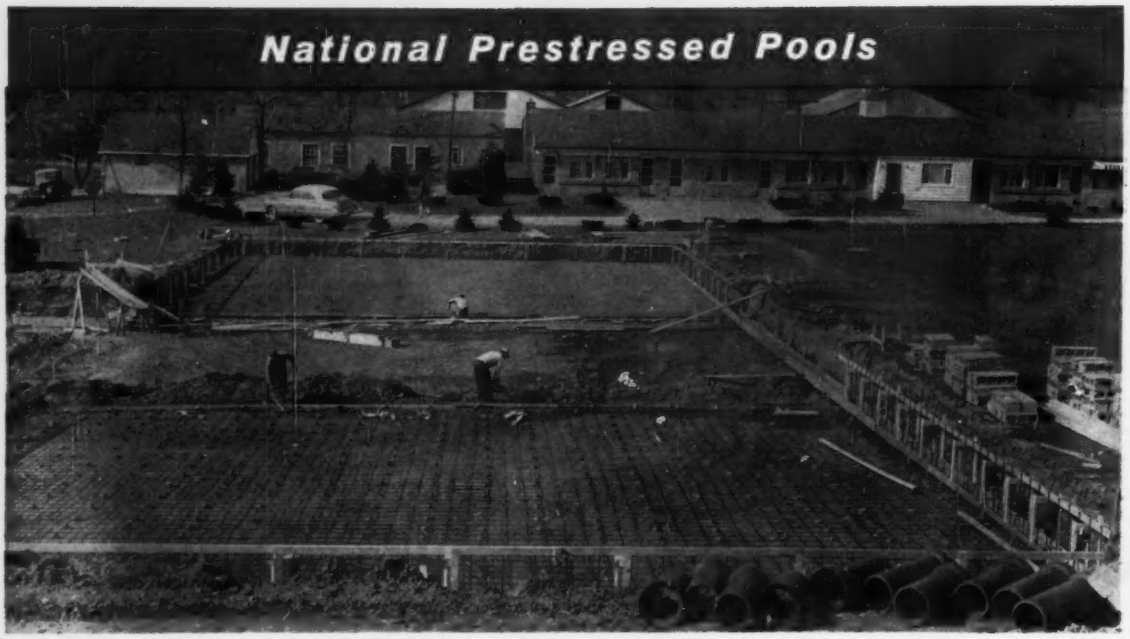
CIVIL ENGINEERING

DECEMBER 1946

THE MAGAZINE OF MODERN CONSTRUCTION



RIVER TUY SUPPLEMENTS CARACAS WATER SUPPLY
SEE ARTICLE BY J. G. PIERETTI AND E. C. COLE



One of the largest motel swimming pools under construction at the Blue Spruce Motel, Murrysville, Pa.

Pre-Stressed, Pre-cast Concrete Units Solve Labor Costs

The NATIONAL POOL package includes all fittings special interlocking concrete units, vertical pre-stressing bars, marble-lite material for interior finish and complete filter system. Construction requires no special equipment and can be done with inexperienced local labor. Specially designed pre-cast interlocking concrete wall sections fit into each other and solves cost problem. Pool walls are scientifically pre-stressed to prevent cracking. New method puts swimming pools within reach of all budgets.

PRICES START AT $1,300.00 for 16′ x 32′ PRIVATE POOL COMPLETE WITH FILTER SYSTEM, PUMP, MOTOR AND FITTINGS. PUBLIC POOL PACKAGE PRICE STARTS AT $3464.00 for 20 x 40 POOL. PUBLIC POOL PACKAGES ARE AVAILABLE FOR OLYMPIC SIZE POOLS.

Superior equipment—filter systems—underwater lights—ladders—vacuum cleaners—diving boards—heaters—paint for pool construction. Write for catalogue and price list.

National Pool retains a highly specialized engineering staff for pool designing and construction. Services available to Architects and Engineers.

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CIVIL ENGINEERING

DECEMBER 1956
VOL. 26 • NO. 12

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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• NEWS BRIEFS

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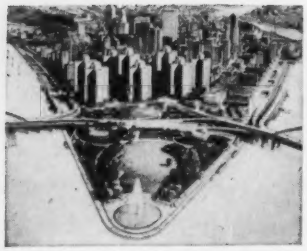
Progress in Pittsburgh....



ALLEGHENY COUNTY AUTHORITY

SPECIFIES LONG LENGTH CONCRETE PIPE with RUBBER and STEEL AMSEAL JOINTS

In keeping with Pittsburgh's remarkable record of progress, the Allegheny County Sanitary Authority is presently constructing an $30,000,000 combined sanitary and storm sewerage system designed to serve 70 communities. Pittsburgh's famous rivers and streams will benefit enormously from this big cleanup job which is one of the largest of its kind in the United States.

American-Marietta's up-to-the-minute facilities in Pittsburgh are supplying many miles of high-quality, long-length concrete pipe with Amseal Joints to many of the nation's leading contractors for their work on both tunnel and open-cut interceptors. Approximately 50 varying sizes and designs are being made on schedule to meet the project's anticipated completion date.

The Amseal rubber and steel joint provides positive protection from both leakage and infiltration while the hard, dense, high-strength concrete guards against devastating and erosive sewage. Long lengths (16 ft.) speed installation, reduce number of joints, and mean real savings to owners both in construction and in operation.

Our technical staff will be pleased to assist you with your pipe problems.

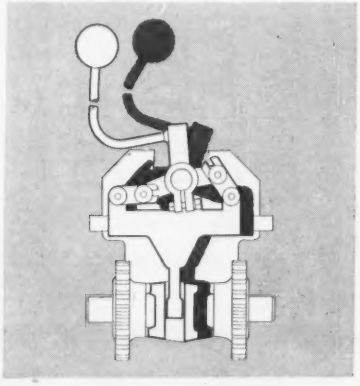
AMERICAN-MARIETTA COMPANY
CONCRETE PRODUCTS DIVISION
GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING
101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS, PHONE: WHITEHALL 4-5600

Report from the Dallas-Fort Worth Turnpike Job

"The Allis-Chalmers Forty Five motor grader has the

BEST CONTROLS I'VE EVER TOUCHED"

That's what veteran motor grader operator R. C. Fryer of Telephone, Texas, says about the new mechanical, toggle-type control levers on the Allis-Chalmers Forty Five motor grader he is operating for the J. C. Watson Construction Co., Dallas, Texas.



FORTY FIVE
120 brake hp • 23,800 lb

And here's why Fryer is so enthusiastic. Toggle-type controls move gears into operating position surely, quickly when operator moves lever . . . but with *no* wrist-snapping kickback. Levers stay put—can't fight back. With no backlash to worry about, Fryer does precision jobs faster and easier.

You've got to see it to believe it

R. C. Fryer is a veteran of the four-mule Fresno days, and his enthusiasm is proof that the Forty Five is motor grader news worth looking into. Check and you'll find toggle-type controls are only one of many features that mean new performance and new operating ease.

The big Allis-Chalmers diesel engine provides real lugging ability. The ROLL-AWAY moldboard rolls the load instead of pushing it . . . moves it faster with less effort. Fully enclosed power steering, new accelerator-decelerator pedal, real operator comfort, excellent visibility, all add up to the kind of production and long-life service you want.

See the Forty Five. Try the Forty Five. Find out for yourself the many advantages that will help you get top performance and big production on your jobs.

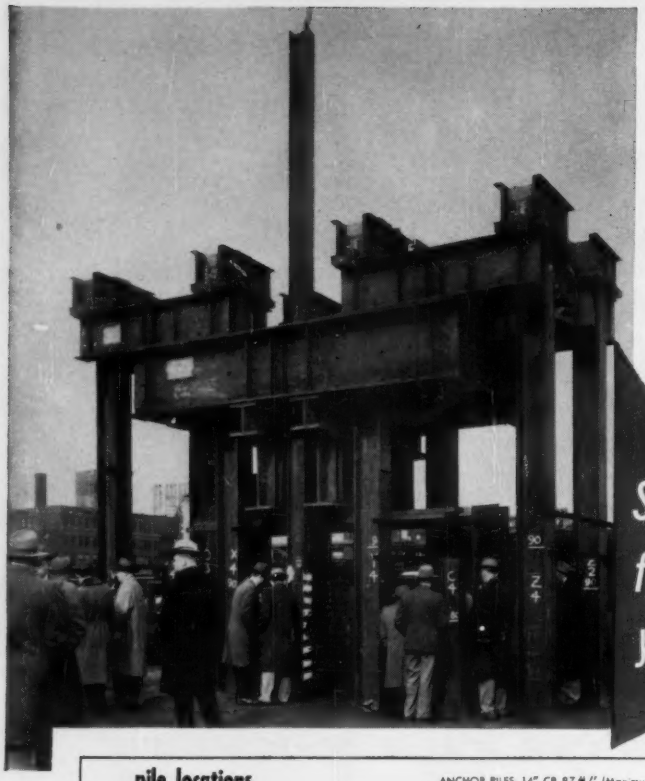
Your Allis-Chalmers dealer has complete facilities to serve you—factory-trained sales and service personnel, factory-approved service equipment and complete stocks of True Original Parts.

ROLL-AWAY is an Allis-Chalmers trademark.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

Chicago tests prove USS Steel



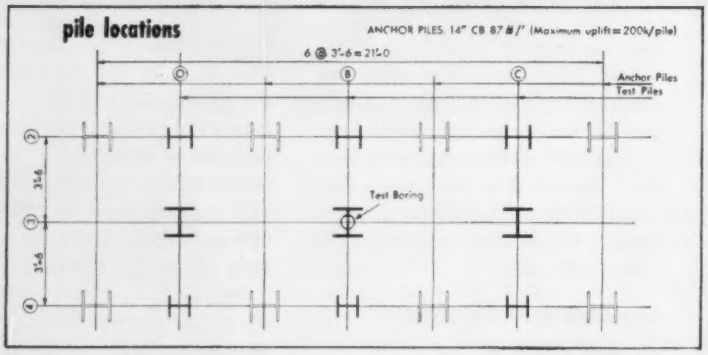
See for yourself

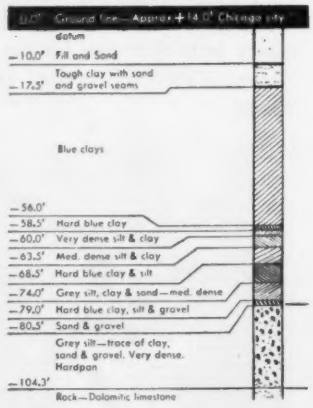
To provide authentic data showing USS steel H-beam piles capable of meeting limits allowed by the City of Chicago Building Code, United States Steel Corporation had the Armour Research Foundation of Illinois Institute of Technology conduct tests on a site having soil conditions typical of the Loop area. Tests were made at the corner of Harrison and Halstead Streets. A total of 17 piles were driven, eight of which were used as anchor piles. Data on the nine test piles is shown in the table below.

USS Steel H-Beam Bearing Pile Test

Pile Number	
Pile Size	
End Conditions	
Proposed Allowable Load—Tons	
Test Load—Tons	
No. of Blows in Last Inch	
Estimated Design Load by ENR Formula‡	
Total Deflection at Proposed Allowable Load	
Total Deflection at Test Load	
Rebound from Test Load	
Total Net Settlement	
Allowable Total Net Settlement by Chicago Code	
Load at Failure—Tons	
Avg. Unit Stress (fs) at Failure—psi	
Total Deflection at Failure	
Rebound from Failure Load	
Net Settlement after Removal of Failure Load	
Manner of Failure	

**Final driving of all piles by Vulcan type OR hammer—30,225 ft. lbs. ‡ENGINEERING NEWS formula.*





THEIR NATURAL ADVANTAGES *make* USS STEEL H-BEAM BEARING PILES *the logical foundation for heavy, multi-story buildings*

The design possibilities, low cost, and ease of installation of USS steel H-Beam bearing piles offer definite advantages over foundation caissons for supporting heavy buildings. Buildings of any height can be founded on steel H-Beam piles without limitations resulting from insufficient penetration. Excessive amounts of free water, marsh gas, and other adverse conditions which sometimes halt construction of open-pit caissons, offer no obstacles to obtaining required design loads with steel H-beam bearing piles. Furthermore, the cost in time, materials, and equipment needed to construct open-pit caissons makes USS steel H-Beam Bearing Piles the most economical type of foundation you can use.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

high load-carrying capacity of H-Beam Bearing Piles

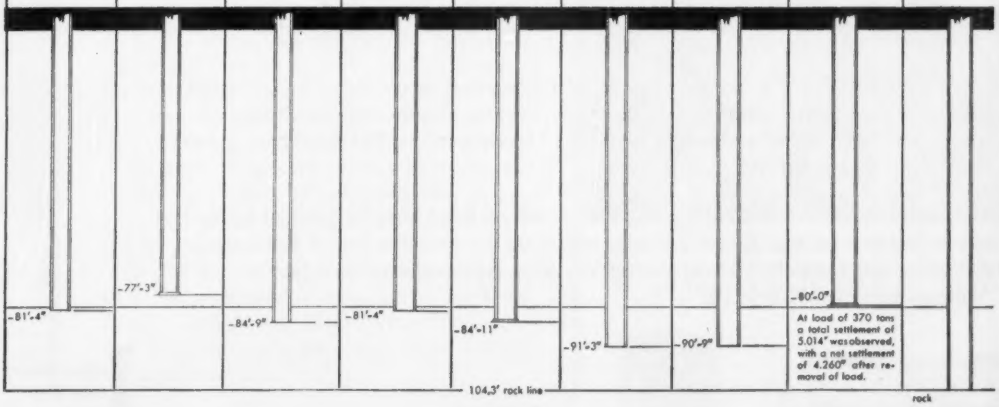
All of the nine piles tested exceeded the requirements of the Chicago Building Code, except for the closed end, 14-inch H-beam bearing pile that failed by excessive net settlement at a load of 370 tons. This pile was not driven to hardpan inasmuch as the desired driving resistance was attained before hardpan was reached. Therefore, it seems logical to assume that for loads of the magnitude of those under discussion, firm seating in hard soil should be a requirement.

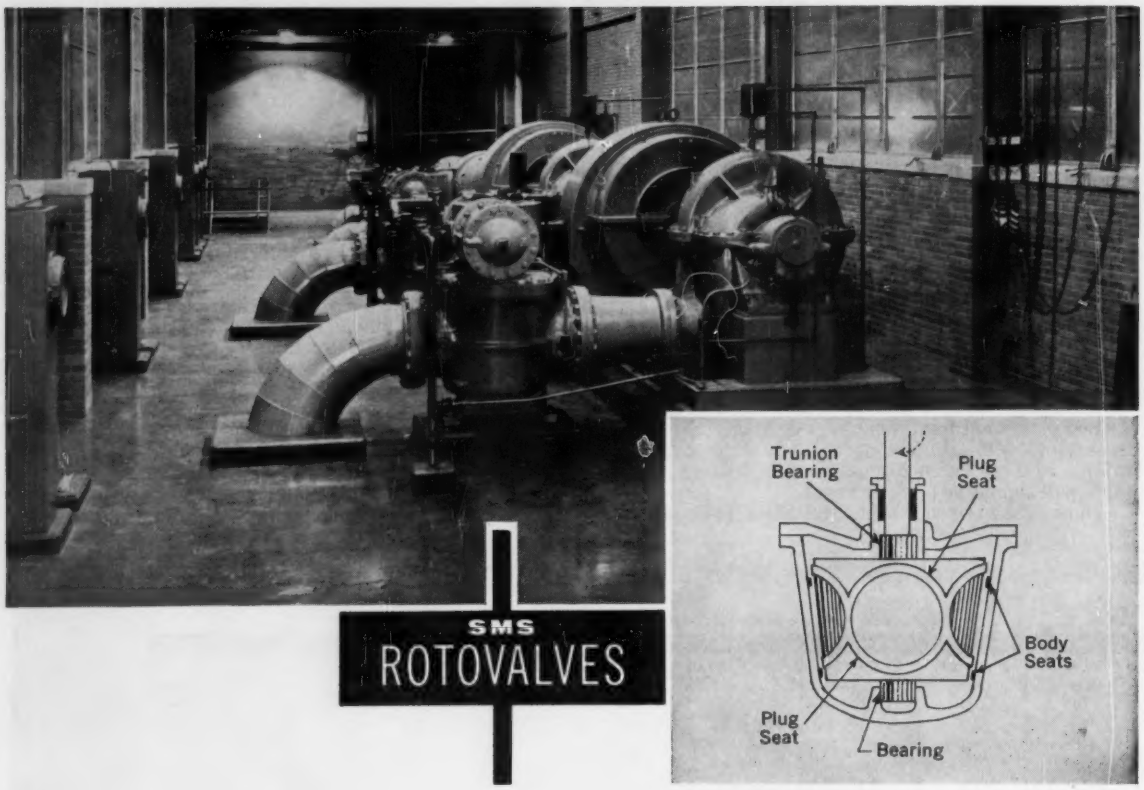
Here again is proof that USS Steel H-Beam Bearing Piles are capable of carrying heavy foundation loads into stable mediums lying at great depth. Their capacity for high unit loads, both vertical and horizontal, permits fewer piles and fewer driving operations for a given load. They are readily handled in the field by ordinary equipment, are easy to splice, eliminate jetting, and withstand rough handling.

If you would like to receive detailed information regarding your particular foundation problems, please contact the office nearest you.

Data* (In accordance with Chicago Code requirements—in addition B4, B2 and B3 were tested to failure.)

O4	C4	B4	O2	C2	B2	O3	C3	B3
10" CBP 42#/'	10" CBP 42#/'	10" CBP 42#/'	12" CBP 53#/'	12" CBP 53#/'	12" CBP 53#/'	14" CBP 117#/'	14" CBP 117#/'	14" CBP 117#/'
Open	Closed	Open	Open	Closed	Open	Open	Closed	Open
75	75	75	100	100	100	200	200	200
150	150	150	200	200	200	400	400	400
10	10	31	7	7	Refusal	22	24	On Rock
151	151	228	124	124	.....	208	213	.....
0.317"	0.312"	0.168"	0.359"	0.338"	0.270"	0.378"	0.454"	0.293"
0.773"	0.976"	0.501"	2.147"	1.321"	0.637"	0.891"	See Below	0.695"
0.633"	0.730"	0.549"	0.754"	0.810"	0.670"	0.723"		0.657"
0.140"	0.246"	—0.048"	1.393"	0.511"	—0.033"	0.168"		0.038"
1.50"	1.50"	1.50"	2.00"	2.00"	2.00"	4.00"	4.00"	4.00"
		240			300			635
		34400 psi			38500 psi			36900 psi
		0.985"			1.079"			2.669"
		0.831"			0.932"			1.176"
		0.154"			0.147"			1.493"
		Local Flange Buckling Above Ground			Local Flange Buckling Above Ground			Yielding Over Cross Section of Pile





SMS-ROTOVALVE DESIGN ASSURES POSITIVE CLOSING, LONG LIFE

For fast, easy operation and positive closing, specify SMS-Rotovalves. As shown above, the conical plug, with full line opening, first lifts, then turns, finally reseats. Bronze trunnions eliminate friction and wear to seats, the causes of failure and breakage. Self-purging monel to monel seating assures drop-tight closure.

Rotovalves are designed to solve your control problems. You can be sure of easy operation, precise aperture control, controlled closing time, positive closure, easy mechanical cleaning, low maintenance and long service life. The Rotovalve's full line opening means less head loss and lower pumping costs.

Performance characteristics like these are the result of more than 75 years of hydraulic research and engineering. To get full information on the complete line of Rotovalves, Ball Valves and Butterfly Valves, contact our local representative or write S. Morgan Smith Co., York, Pa.

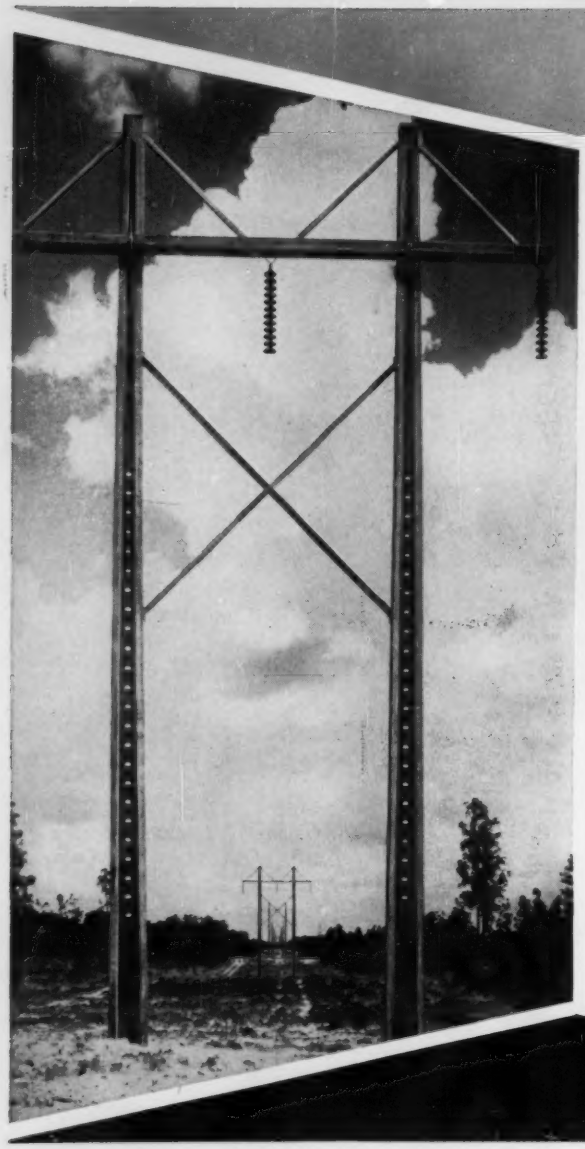
S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
ACCESSORIES

HYDRODYNAMICS

ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS



TODAY...

Roebling tensioning materials have created many markets for prestressed concrete . . .

warehouses • garages • stadiums

bridges • piers • hangars

and other construction

TODAY...

Another new market for fabricators

Prestressed* Concrete Line Poles

Shown here is one of the latest in the constantly growing list of applications for prestressed concrete. These power line poles were designed and fabricated for the Florida Power Corporation by Finfrock Industries, Inc., Orlando, Florida.

Each pole is prestressed with $\frac{3}{8}$" diameter Roebling uncoated 7-wire stress-relieved strands, pretensioned and bonded to the concrete.

Easily transported and installed, the 65 ft (above ground) poles have a life expectancy of 50 to 100 years. Once erected, they are maintenance-free. The high cost of replacement every few years is eliminated.

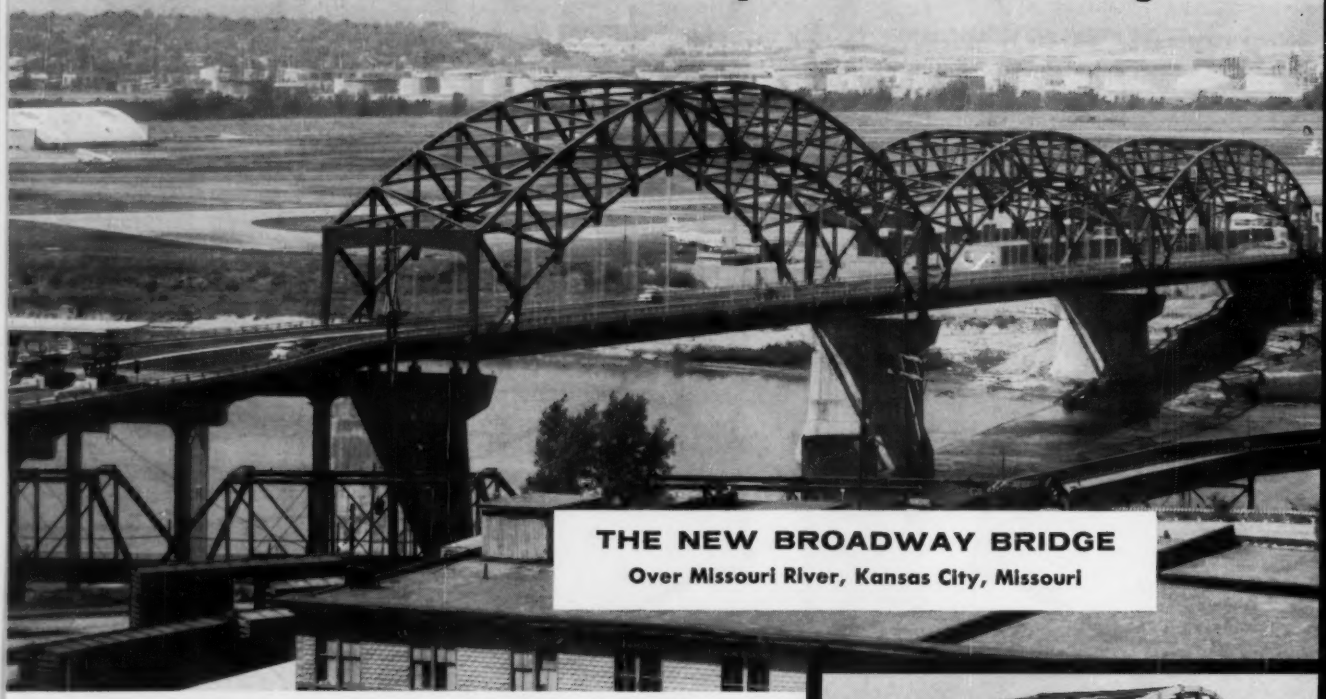
Why don't you investigate the possibilities of this new market to increase your profits? Roebling engineers, who pioneered in the development of prestressed concrete in America, will supply general information or help with specific problems. Write to Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

ROEBLING

A Subsidiary of The Colorado Fuel and Iron Corporation

*Not *to be confused with ordinary reinforced concrete*

Another Important Highway Bridge
fabricated and erected by American Bridge



THE NEW BROADWAY BRIDGE
Over Missouri River, Kansas City, Missouri

THIS HANDSOME NEW 4-lane bridge replaces the highway services of the adjacent Hannibal Bridge (built in 1917), which carried the highway on its upper deck, and will continue to carry the tracks of the Chicago, Burlington & Quincy Railroad on its lower deck.

The structure consists of three Thru Tied Arch Truss Spans, one 540′ long and two of 450′; a South Approach which is made up of two Thru Plate Girder Spans, each 113′ long, and nine Deck Plate Girder Spans, ranging in length from 90′ to 125′-6″; and a 1161′-long North Approach composed of 20 continuous Beam Spans.

All of the 7,277 tons of structural steel for this new bridge was fabricated by American Bridge. In addition, American Bridge erected the three river spans. Field connections were riveted, bolted and welded.

The Broadway Bridge in Kansas City is the most recent of the hundreds of highway bridges built by American Bridge. You'll find them in every state . . . on practically every important highway. In over fifty years of building bridges of every type and size, American Bridge has accumulated a vast and valuable experience in this highly specialized field of construction. If you would like to know more about our ability, skilled personnel, and fabricating and erecting facilities, just call our nearest Contracting Office.

All designs by: Howard, Needles, Tammen & Bergendoff, Consulting Engineers, Kansas City, Mo.

Owned by Municipality of Kansas City, Mo. (Who handled all planning, programming and financing independent of state or federal aid.)

Contractor for three river spans: American Bridge Division.

Contractor for South Approach: Guy H. James Construction Co. and Foster-Smetana Co.

Erection of South Approach sublet by American Bridge to: John F. Beasley Construction Company.

Contractor for North Approach: L. G. Barcus & Son Construction Company.

INTERESTING MOTION PICTURES AVAILABLE—"Building for the Nations" and "The Suspension Bridge," two entertaining and educational films, are now available without charge to business, fraternal and civic organizations, churches, schools and colleges. Write to Pittsburgh office for bookings.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

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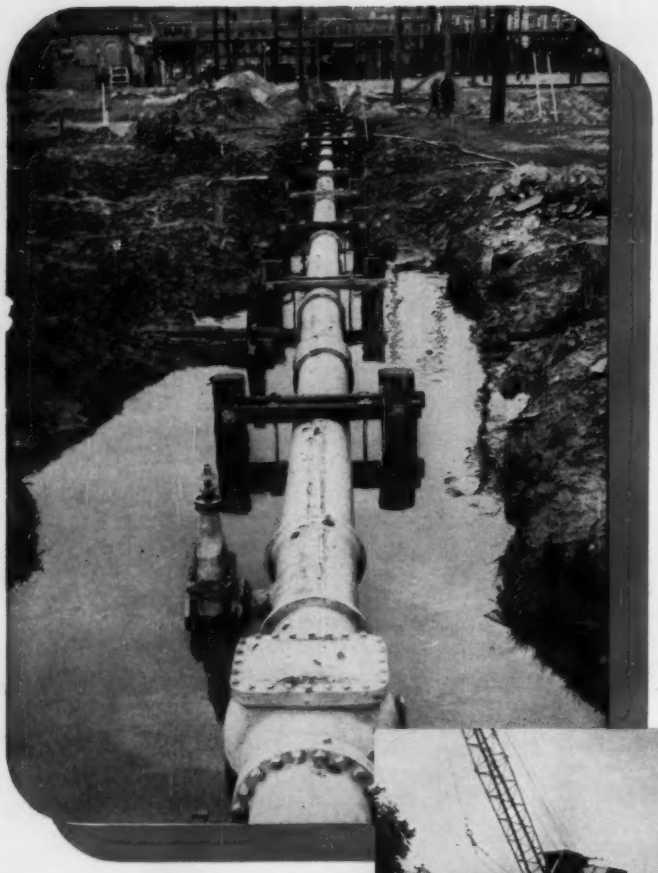
UNITED STATES STEEL

You can bank on it for jobs



20" Mechanical Joint Water Feeder Main installed at Atlantic City, N. J.

About 14 miles of 16" Mechanical Joint pipe installed for supply line for water district in South Carolina.

When your reputation is at stake...when the public deserves and should get dependable service... play safe by installing cast iron pipe. Through our consistent program of national advertising, the public knows that cast iron pipe serves for centuries—is reliable and economical. Today, *modernized* cast iron pipe, centrifugally cast, is even tougher, stronger and more uniform in quality than the pipe our industry made a century ago. For further information, write Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Avenue, Chicago 3.

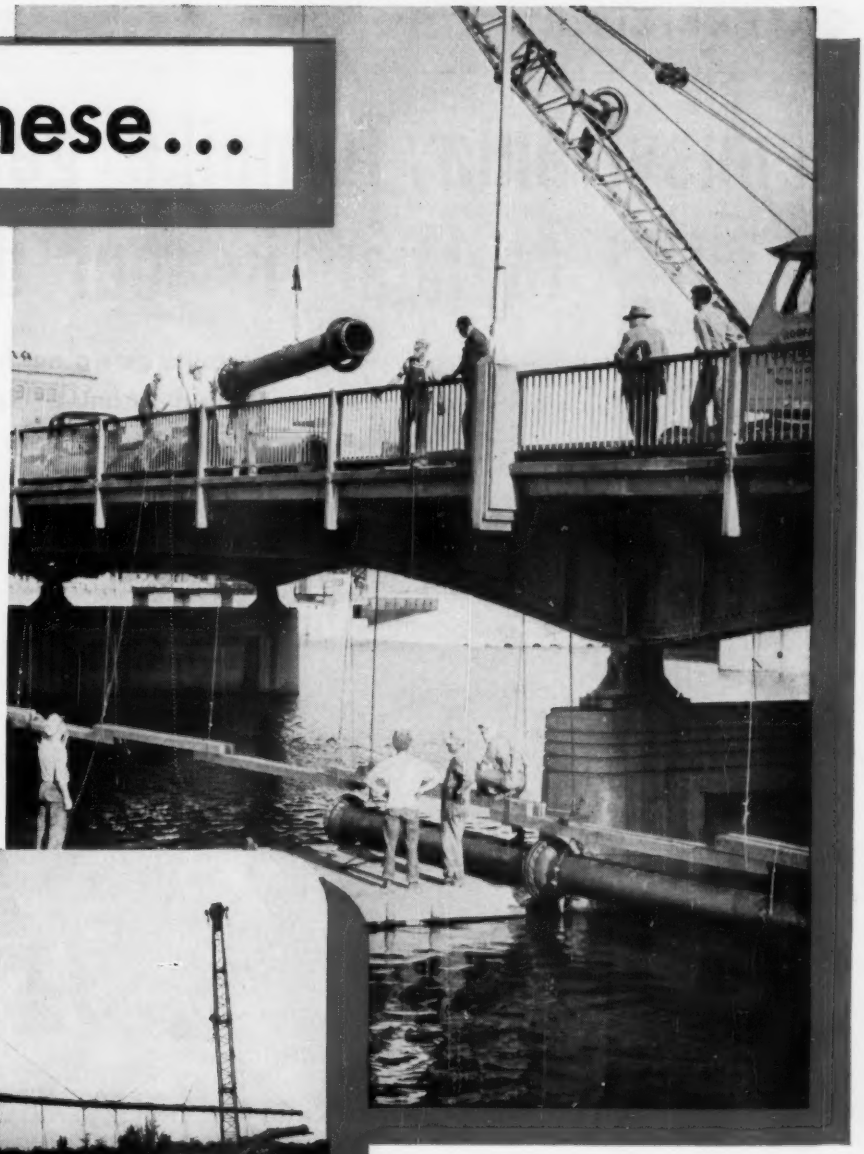
CAST Q IRON

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

Nearly two miles of 6" to 20" cast iron pipe for potable, process, and fire protection water systems and sewer system for petrochemical plant in Tuscola, Illinois.

CAST IRON PIPE

like these...



Flexible Joint cast iron pipe being laid across 600 feet-wide river at Waterloo, Iowa, for feeder line operating under 85 psi water pressure.

Installing 24-inch Flexible Joint cast iron pipe for river crossing at Fort Lauderdale, Florida.

SERVES FOR CENTURIES...

Pennsylvania Turnpike gets ready to head in four directions

The veteran east-west turnpike gets a north-south extension. Look how construction techniques and equipment have improved since the original highway was completed.

Six DW21s and PR21s help Badgett Mine Stripping Corp. move 5,000,000 yards. Averaging two trips an hour over a round-trip haul of 3 miles, these units averaged loads of 16 yards. Says the foreman, ". . . the best machine of its kind."

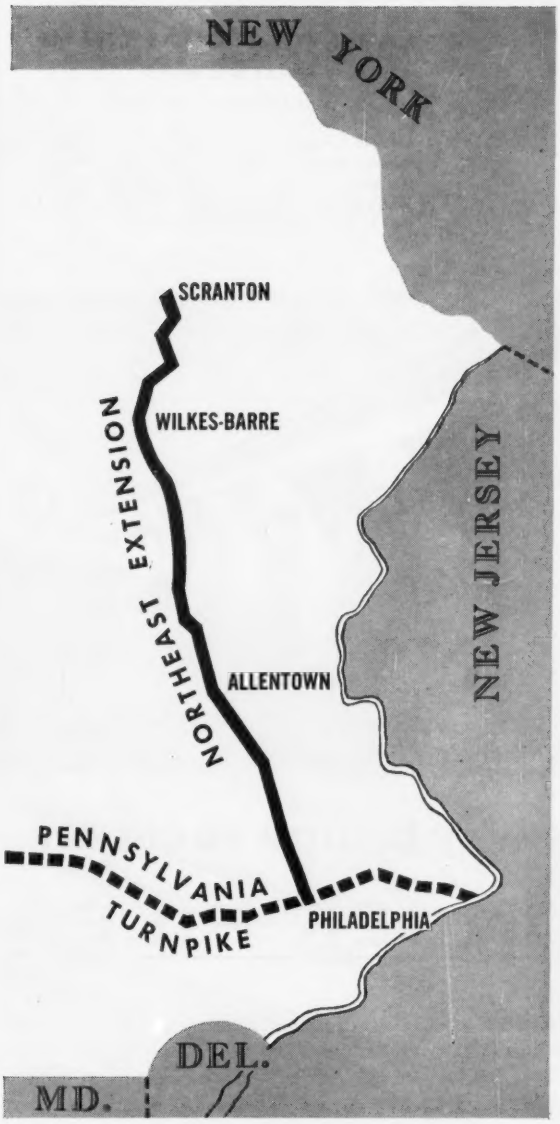
The Pennsylvania Turnpike, granddaddy of all the nation's super-toll roads, is getting a north-south link.

Called the Northeast Extension, the $196 million superhighway will roll 110 miles—connecting Scranton to the east-west portion of the Turnpike near Philadelphia. Terrain ranges from flat farmland and timber tracts to the rugged, rocky Pocono Mountains and abandoned anthracite diggings. It crosses 4 rivers and 16 streams. Contractors are building 133 bridges, 142 culverts and punching a 4300-foot tunnel through a mountain. When completed the road will have consumed 70,000 tons of steel, 4 million tons of stone and sand, 714,207 tons of fine aggregate, and 1,782,526 tons of coarse aggregate. No grade will exceed 3%.

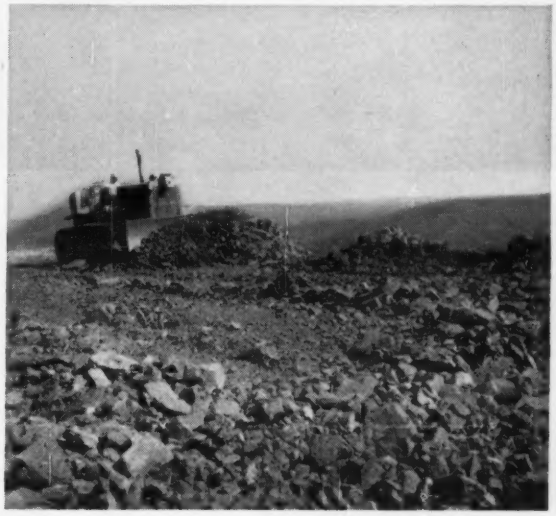
The road will make use of a new idea in medial strips. Traffic will flow on both sides of a 4-foot-wide concrete separation, 8 inches high. This is expected to provide increased safety and save construction costs.

Money is being saved, too, by the fleets of Caterpillar equipment at work—machines with work capacities unknown when the original Turnpike was built. Says P. C. McGee, superintendent for Central Pennsylvania Quarry, Stripping and Construction Co., which is moving 2,750,000 yards on 10.04 miles:

"I used to be an operator and I feel that Caterpillar makes the best road equipment you can buy. Since I have become a superintendent, I am more cost conscious. Now I know that CAT* machines give you



Northeast Extension runs from the Philadelphia area to Scranton across the rugged Pocono Mountains. It requires, among other things, a 4300-foot tunnel.



No. 12 Motor Grader (above) and D8 (below) team up for Central Pennsylvania Construction Co. on a 97-foot fill. In rocky going, they spread and graded a 150 foot x 80 foot area per hour.

more work for the money than other road equipment."

Central Pennsylvania's big yellow fleet includes D7s, D8s and No. 12 Motor Graders. Since the original Pennsylvania Turnpike mileage was built, the D8 has had its production increased with improvements like these: a new 191 HP Diesel Engine . . . torque converter . . . the exclusive Caterpillar oil clutch. And the No. 12 now packs 115 HP, faster reverse speeds, tubeless tires, and the new oil clutch.

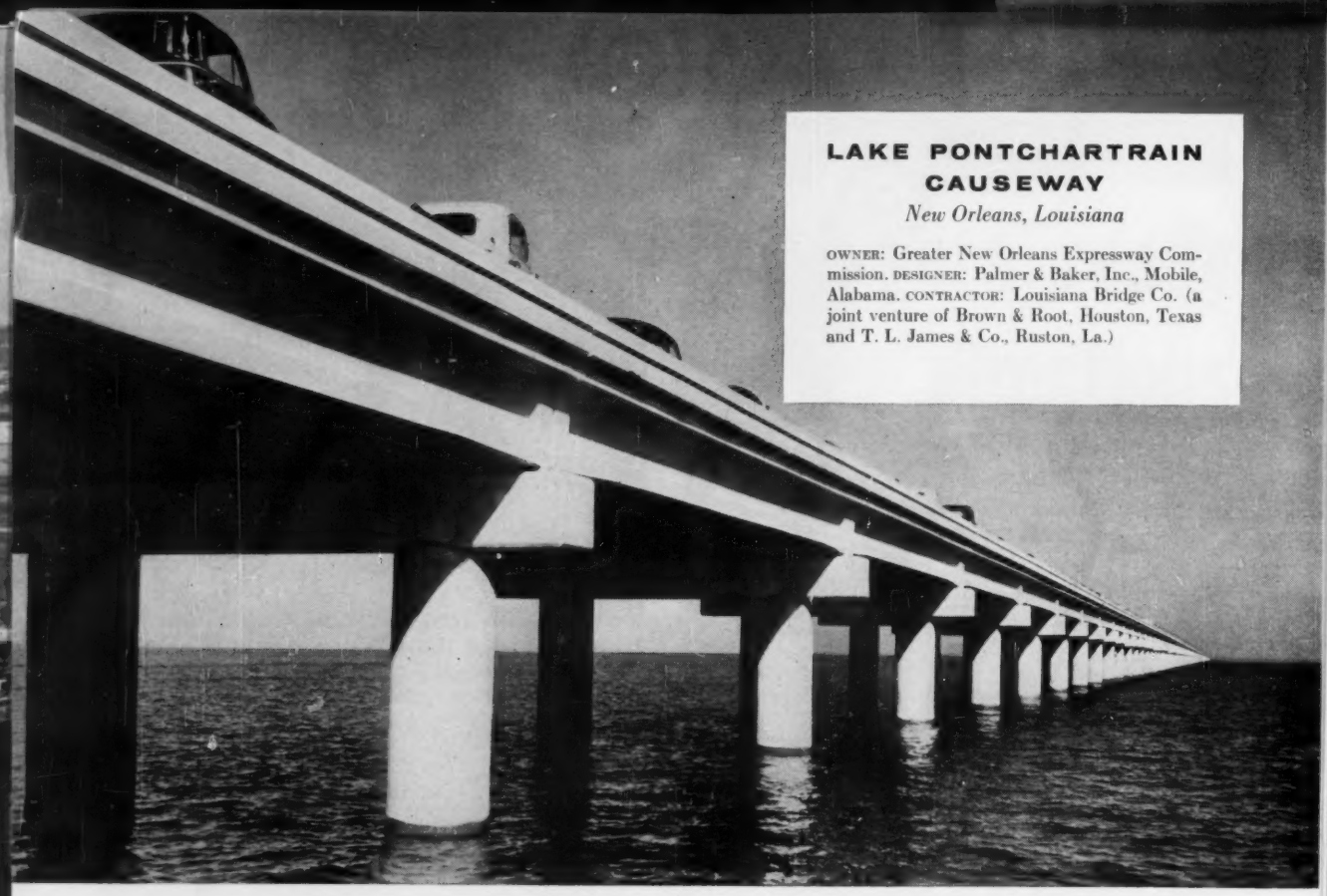
On another part of the Northeast Extension, Badgett Mine Stripping Corp., Madisonville, Ky., is moving 5,000,000 yards on a 6.91-mile stretch. Its Caterpillar fleet includes 6 DW21s with Athey PR21 Wagons. Neither unit existed when the original Turnpike was built. Today, the DW21, powered by a Cat Turbocharged Diesel with a maximum output of 300 HP, can develop rimpulls ranging to 38,240 pounds. The PR21, teamed with a DW21, can carry up to 22.5 cubic yards, make 90-degree turns to either side.

Reports Roy N. Holley, grade foreman: "They keep on working when other haul units break down. That's why they haul more dirt. And they let us operate faster in tight spots."

The Northeast Extension illustrates clearly the giant strides made by the construction industry and its Caterpillar equipment in a few short years.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.



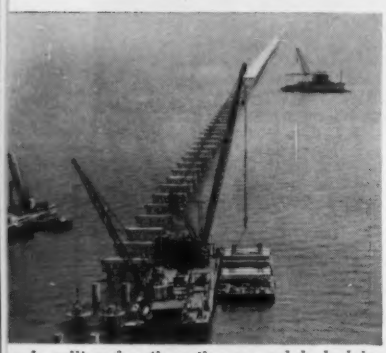
LAKE PONTCHARTRAIN CAUSEWAY

New Orleans, Louisiana

OWNER: Greater New Orleans Expressway Commission. DESIGNER: Palmer & Baker, Inc., Mobile, Alabama. CONTRACTOR: Louisiana Bridge Co. (a joint venture of Brown & Root, Houston, Texas and T. L. James & Co., Ruston, La.)

The world's longest highway bridge rests on

RAYMOND CYLINDER PILES



Installing the piles, pile caps and deck slabs.

The 37 acre manufacturing yard, built specifically for this job.

By using simplified design and unique assembly line construction methods, the $30,700,000 new Lake Pontchartrain Causeway, stretching 24 miles from the outskirts of New Orleans to Mandeville, La., was completed four months ahead of schedule. The use of Raymond Prestressed Concrete Cylinder Piles was a major factor in the saving of time and money in this project. Under the direction of Raymond engineers, a pile fabrication yard was constructed at the bridge site. Just three months after the manufacturing yard was started, the first Raymond Cylinder Pile came off the assembly line and was floated to the installation point. In all, the contractor, who was licensed to manufacture and install the Raymond Piles, used 4,886 fifty-four inch piles averaging 88 feet in length, 2,240 pile caps and 2,232 185-ton Prestressed Deck Slabs in the bridge.

Naturally, we are proud to have played such an important part in this gigantic construction achievement. And we will be equally proud to apply our experience to your foundation problems—no matter how large or small.

RAYMOND AROUND THE WORLD FOUNDED 1891 at home and abroad

IN THIS COUNTRY

Foundations . . . Marine Structures . . .
Heavy Construction . . . Soil Investigations.

OUTSIDE THE UNITED STATES

Complete services for all types of construction.

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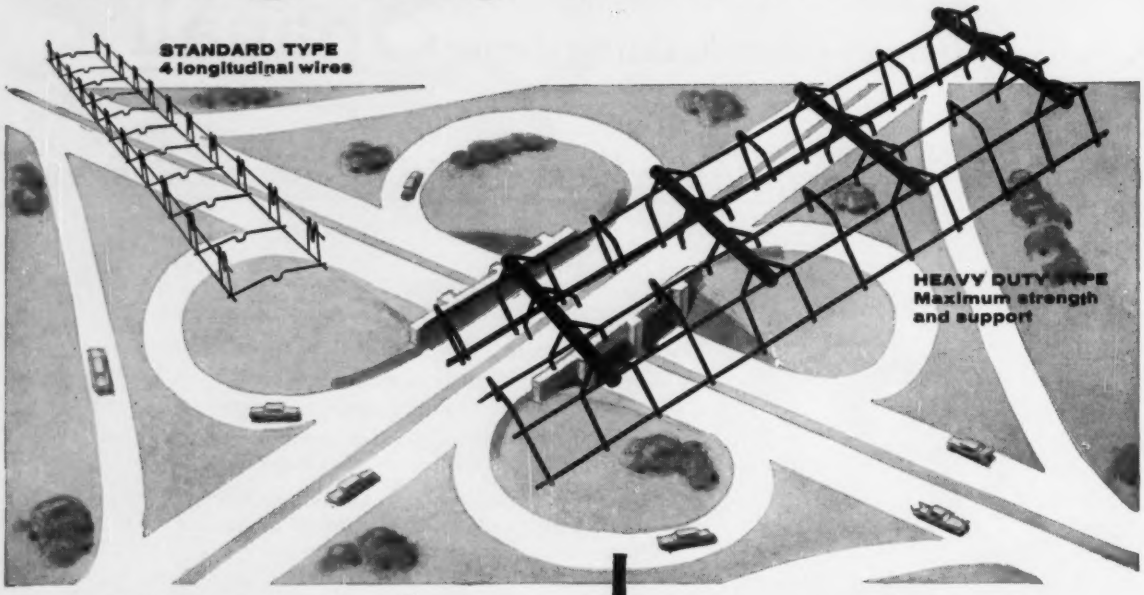
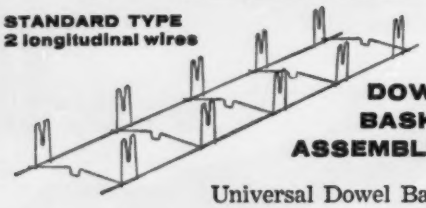
for highway construction

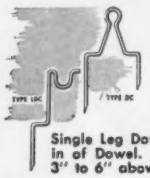




DOWEL BASKET ASSEMBLIES

Universal Dowel Basket Assemblies are designed and fabricated to specifications. Special equipment and fixtures guarantee accurate spacing and positive alignment of dowels. High speed production equipment and modern facilities insure prompt delivery of your requirements. Universal Baskets are approved by Federal, State and private authorities for highway and airport construction.

Let us quote on your requirements. Write for complete details today.



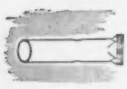
INDIVIDUAL DOWEL CHAIRS

Two-legged dowel chair holds dowel in 2 positions. Easily pushed into sub-grade—won't turn after installation. Wide range of heights.

Single Leg Dowel Chair permits quick snap-in of Dowel. Sizes to support Dowel from 3" to 6" above sub-grade.

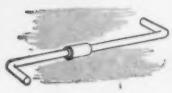
STAKE PINS

Keep Dowel Bar Assemblies in place during the pour. Lengths from 4" to 15" in ¼" increments.



DOWEL SLEEVES

Metal Dowel Sleeves for covering ¾" Dowel Bars; overall length covers 2½" or 3" Dowel. Special sizes and lengths available.



HOOK BOLT ASSEMBLY

For providing required tieing element along longitudinal joint. Eliminates necessity of bending tie bars or drilling road forms.

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Service Wherever You Build... Coast to Coast

Can Your Water Pipe Withstand Three Times the Working Pressure?

As this chart shows, steel water pipe can withstand at least three times the calculated maximum allowable working pressure before bursting.

THEORETICAL INTERNAL PRESSURES OF STEEL PIPE

	1/4 in.			5/16 in.			3/8 in.			7/16 in.			1/2 in.		
INSIDE DIAM IN.	EST SHIP WT LB/FT	MAX WRK PRESS PSI	MIN BURST PRESS PSI	EST SHIP WT LB/FT	MAX WRK PRESS PSI	MIN BURST PRESS PSI	EST SHIP WT LB/FT	MAX WRK PRESS PSI	MIN BURST PRESS PSI	EST SHIP WT LB/FT	MAX WRK PRESS PSI	MIN BURST PRESS PSI	EST SHIP WT LB/FT	MAX WRK PRESS PSI	MIN BURST PRESS PSI
18	50	445	1390	62	555	1735	75	665	2080	88	775	2430	101	890	2780
20	55	400	1250	69	500	1560	83	600	1875	97	700	2180	111	800	2500
22	61	365	1135	76	465	1420	91	550	1700	107	640	1985	122	730	2270
24	67	335	1040	83	420	1300	100	505	1560	116	585	1820	133	665	2080
30	83	270	835	104	340	1040	125	405	1250	145	475	1455	166	535	1670
36	104	225	695	128	280	870	154	340	1040	179	395	1210	204	445	1390
42	116	195	595	144	240	745	173	285	890	202	335	1040	231	380	1190
48	132	170	520	165	210	650	198	250	780	231	290	910	264	330	1040
54				186	190	580	223	225	695	260	260	810	297	295	925
60				207	170	525	248	200	625	289	235	730	330	265	835
72							306	170	520	355	195	605	405	220	695
84							346	145	450	403	170	520	460	190	595
96	The recommended minimum wall thickness is approximately the pipe diameter divided by 165. Pipe having this diameter-thickness ratio, when backfilled and properly tamped, will withstand any depth of cover. For buried pipe, the recommended minimum wall thickness is shown immediately to the right of the heavy black line.									464	145	455	524	165	520
108													*605	150	465
120													*656	135	415

*Under certain conditions stiffeners may be required to reduce deflections.

$P = \frac{t \times Ts}{r}$ P = internal pressure, psi t = thickness, in. Ts = allowable unit stress = 60% x 27,000 (yield point) = 16,000 psi

r = radius of pipe, in. Based on use of ASTM A-283, Grade B Steel, 50,000 psi min. ultimate tensile strength

Take a look at just two examples:

(A) If you select 36 x ¼ in. steel pipe, AWWA design standards allow a maximum working pressure of 225 psi, well in excess of ordinary pressures. Yet your *minimum* bursting pressure is 695 psi—over three times the working pressure.

(B) Now look at 60 x ⅜ in. pipe. With a maximum allowable working pressure of 200 psi you get a minimum bursting pressure of 625—that's triple, with plenty to spare!

Don't gamble with slim margins of safety. Don't take chances with water lines. Bethlehem Steel Pipe costs no more than other materials—actually *costs less* to install—and gives you reliable performance.

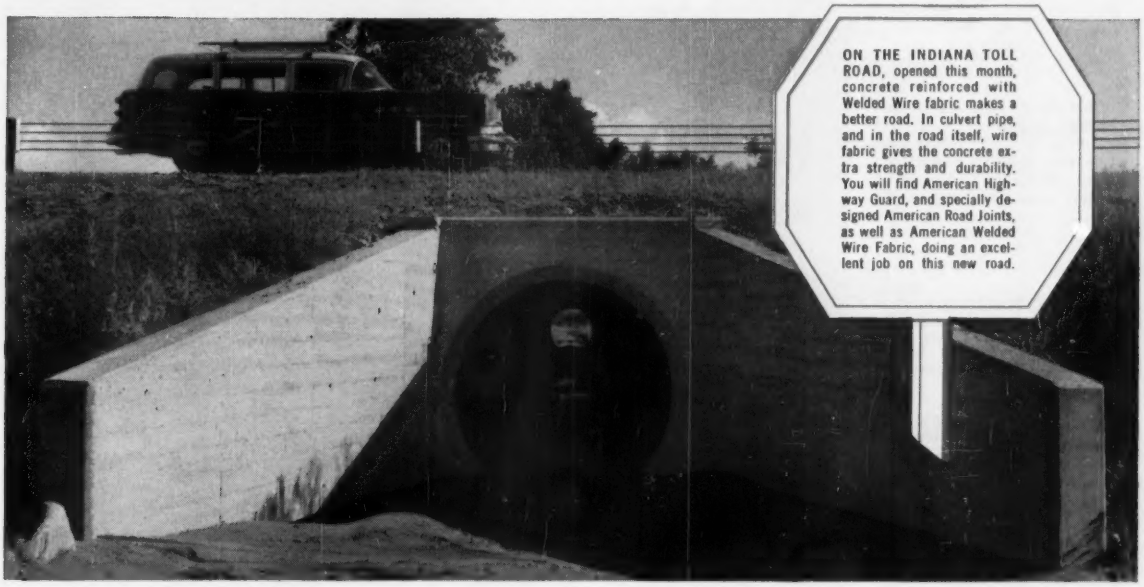
Remember, *every length of Bethlehem Steel Pipe is hydrostatically tested in accordance with AWWA standards, usually to twice the working pressure!* For further facts see the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Highly Stressed Concrete Lasts Longer
when reinforced with
American Welded Wire Fabric



ON THE INDIANA TOLL ROAD, opened this month, concrete reinforced with Welded Wire fabric makes a better road. In culvert pipe, and in the road itself, wire fabric gives the concrete extra strength and durability. You will find American Highway Guard, and specially designed American Road Joints, as well as American Welded Wire Fabric, doing an excellent job on this new road.

Concrete roads, floor slabs, pipe, walls, sidewalks—all are improved with Welded Wire Fabric reinforcement. They have greater resistance to cracking, last longer, and stay smoother. And now, for concrete that must withstand unusually high stresses, American Welded Wire Fabric comes in larger sizes than formerly. It's now available in diameters up to and including ½″, at 2″, 3″, 4″, and 6″ on center. It meets ASTM Specification A 185 56T.

The high quality of American Welded Wire Fabric is rigidly controlled from iron mine to you. Made from tough, cold-drawn steel . . . then electrically welded together into a strong network of durable reinforcement, it cuts maintenance cost because it increases service life of concrete. It cuts *installation* costs because it is easily handled and placed. It comes in both sheets and rolls. Send the coupon for helpful literature on this and other construction materials manufactured by American Steel & Wire.

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"is it Reinforced"
USS American Welded Wire Fabric
UNITED STATES STEEL

FREE TECHNICAL DATA

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Cleveland 13, Ohio

Please send complete information on the following products:

- ☐ American Welded Wire Fabric for Portland Cement Concrete
- ☐ American Welded Wire Fabric for Asphaltic Concrete
- ☐ American Welded Wire Fabric for Airport Runways
- ☐ American Wire and Strand for Prestressed Concrete
- ☐ American Road Joints
- ☐ Multisafty Highway Cable Guard
- ☐ American Beam-type Highway Guard
- ☐ Have your representative call

Name .....
Firm .....
Address .....
City ..... **State**.....

Rocky Mountain highway needs Skid-resistant pavement

Constructing skid - resistant Texaco Asphaltic Concrete pavement on U. S. Route 550, where this highway crosses the Molas Divide in Colorado at an elevation of 10,000 feet.

CONTRACTORS

Lowdermilk Brothers Construction Company, Denver, Colo.

Sterling Sand & Gravel Company, Fort Collins, Colo.

Completed Texaco Asphaltic Concrete surface at the left and the 6-inch broken stone base at the right.

U. S. Route 550 crosses the Molas Divide near Silverton, Colo., about 10,000 feet above sea level. On the curves and grades of such a mountain highway, dependable skid-resistance is an exceptionally important quality in a pavement.

A hot-mix Texaco Asphaltic Concrete pavement has been constructed on this 6.8 mile section of US-550. Laid to a compacted thickness of two inches, this skid-resistant, rugged wearing surface is supported by a six-inch foundation of crushed stone. The Texaco asphalt surface and the stone base form a completely flexible pavement from the subgrade up, which is capable of absorbing heavy traffic year after year, with a minimum of maintenance.

Hot-mix Texaco Asphaltic Concrete is one of the many heavy-duty, intermediate and low-cost types of construction for highways, streets, airports and parking areas obtainable with Texaco asphaltic products. Helpful information about the methods and materials recommended for all these types is supplied in two free book lets. Copies may be obtained without obligation from our nearest office.

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It's Transite Ring-Tite Pressure Pipe

• Transite® Ring-Tite® Pressure Pipe is a community investment that pays off year after year!

Its remarkably high flow characteristics protect that investment by keeping maintenance and pumping costs at a minimum during its long service life.

Corrosion Resistant

Transite Pipe is strong, durable, and highly resistant to corrosion. And it is immune to tuberculation, the form of interior corrosion that chokes the flow and increases pumping costs. Transite cannot tuberculate, thus its original high flow capacity is maintained, and pumping costs are kept at a minimum year after year.

The Ring-Tite Coupling, with rubber rings compressed and locked in place forms a joint that is tight yet flexible. Rings cannot blow out, and the automatic separation of the pipes within the coupling helps to relieve line stresses.

For further information about Transite Pressure Pipe and the Ring-Tite Coupling, write for Booklet TR-160A. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE PRESSURE PIPE

WITH THE RING-TITE COUPLING

NEWS OF ENGINEERS

George D. Clyde is the new governor-elect of the state of Utah. Governor Clyde will resign his post as Commissioner of Interstate Streams for Utah on January 1 to assume his new duties. The holder of engineering degrees from Utah State and the University of California at Berkeley, he was dean of engineering at Utah State Agricultural College from 1935 to 1945 and chief of irrigation and water conservation for the U. S. Department of Agriculture before taking over his present post. (October issue, Page 27).

George D. Clyde

John W. Clingerman has been appointed product manager in charge of specialty products for U. S. Steel's American Bridge Division in Pittsburgh, Pa. Mr. Clingerman has been associated with U. S. Steel since 1935 with time out for service in the Navy, and since 1954 has been assistant contracting manager of the Specialty Products Division.

Chester W. Cambell has been named president of the Foundation Company of New York. Mr. Cambell has been with the company since 1926, holding the position of project manager prior to his recent appointment.

John P. Redwood, consulting engineer and public utility analyst of New York City, has been appointed by the Westchester County Board of Acquisition and Contract to assist in representing it before the Public Service Commission in its case against the New York Central, which is attempting to increase commuter rates and discontinue passenger service on the Putnam Division.

Ralph Budd, retired chairman of the Chicago Transit Authority and former president of the Great Northern and the Burlington-Rock Island railroads, is this year's recipient of the Award of Merit of the American Institute of Consulting Engineers. The citation hails him as a "distinguished American, outstanding engineer, able administrator, inspiration to young engineers; pioneer in the development of his country through leadership in transcontinental rail and motor transportation." Presentation of the award to Mr. Budd took place at the AICE's annual dinner at the Waldorf-Astoria in New York on November 27.

John J. Theobald, who is serving as deputy mayor of New York while on leave for a year from the presidency of Queens College, received the annual award for distinguished service of the New York chapter of the New York State Society of Professional Engineers at the organization's recent annual dinner held in the Statler Hotel. Dr. Theobald is a former dean of administration and professor of civil engineering at the College of the City of New York.

Leslie D. Harrison, civil and structural engineer of Columbus, Ohio, announces a change in his firm name to Freshwater and Harrison & Associates, Architects and Engineers, with new offices located at 3763 North High Street, Columbus.

Charles Rufus Harte, construction engineer of the New York, New Haven and Hartford Railroad Co., New Haven, Conn., has been named to receive the Standards Medal of the American Standards Association, awarded annually for leadership in the development and application of industrial standards.

Arthur F. Kirstein has joined the staff of the Structural Engineering Section of the National Bureau of Standards in Washington, D. C. He will primarily be working on the development of criteria for predicting the types of structural failures in reinforced concrete beams. For the past two years, Mr. Kirstein has been in fundamental and developmental research at the David Taylor Model Basin in Washington, D. C.

Anton A. Kalinske has been appointed vice-president of Infilco Inc., Tucson, Ariz. An expert in the field of fluid mechanics, Mr. Kalinske has been director of research and development for Infilco for the past ten years.

G. Robert Koch has resigned as hydropower and hydraulic engineer for Uhl, Hall and Rich at Massena, N. Y., to return to Sanderson & Porter, consulting engineering and construction firm of New York City. Mr. Koch has been making extensive power studies on the St. Lawrence Project at Massena for the past three years. In his new position, he will be in charge of investigations and reports relating to hydro-electric developments and power surveys, both foreign and domestic.

Randolph H. Dewante announces the formation of a partnership with **Edwin R. Stowell** under the firm name of Dewante and Stowell, sanitary and civil engineers, with offices at 2015 J Street, Sacramento 14, Calif.

Herman Tachau, an engineer with the New Mexico State Highway Department, received first prize of $5,000 in the recent competition for ideas to accelerate the progress of arc welding sponsored by the James F. Lincoln Arc Welding Foundation. **Van Rensselaer P. Saxe,** consulting engineer of Baltimore, Md., received the second award of $4,000; **Thomas C. Kavanagh,** consulting engineer of New York City, the third award of $3,000; and **Bruce G. Johnston,** professor of structural engineering at the University of Michigan, $2,000. Twenty awards totaling $20,000 were made to engineers in 16 different states.

Nathaniel P. Hayes, president of the Carolina Steel and Iron Co., Greensboro, N. C., was recently elected president of the American Institute of Steel Construction. Mr. Hayes was elected to the board of directors of the AISC in 1947, and has served as vice-president for the past two years.

Harvey F. Ludwig has resigned as chief of the Office of Engineering Resources, Division of Sanitary Engineering Services, U. S. Public Health Service, Washington, D. C., to accept the position of assistant manager of Hycon Aerial Surveys, at Pasadena, Calif.

New president of the Federation of Sewage and Industrial Wastes Associations for the coming year is **Emil C. Jensen,** chief of the Division of Engineering and Sanitation of the Washington State Department of Health. For the past few months Mr. Jensen has been serving the organization as vice-president filling the unexpired term of **John W. Cunningham** (November issue, page 94).

Milton Pikarsky, partner in the firm of Plumb, Tuckett and Pikarsky, consulting engineers and architects of Gary, Ind., is in charge of the new branch office the firm recently opened in Chicago. The office is located in the Kimball Building, 25 East Jackson Blvd.

Karl Terzaghi, Honorary Member of ASCE and international authority on soil mechanics, has been appointed lecturer and research consultant in soil mechanics for the current academic year at the Massachusetts Institute of Technology. Dr. Terzaghi is professor emeritus of civil engineering at Harvard University, where he had a long and distinguished teaching career.

Bernard S. Appleton has been appointed assistant manager of the Greer Corp., Jamaica, N. Y. He was formerly assistant chief engineer of the Greer Marine Corp. at Freeport, N. Y.

Ezra B. Whitman, Past-President of the Society, retired on November 1 from active partnership in the Baltimore firm of Whitman, Requardt & Associates. He will continue to act as consultant to the firm and will maintain his same office in the firm's building. Mr. Whitman is a former veteran of World War I, and chairman of the Maryland Public Service Commission and the Maryland Public Road Commission.

Ezra B. Whitman

Charles H. Mullis, Jr., recently joined the staff of the Esso Research and Engineering Company's design division. Mr. Mullis is a civil engineering graduate of Georgia Institute of Technology, where he also received his master's degree in civil engineering recently.

Alfred O. Quinn has been promoted to chief engineer of the Aero Service Corporation, Philadelphia, Pa. Mr. Quinn has been associated with Aero since 1950, heading the Engineering and Field Surveys Divisions. His new duties will include formation of a technical department charged with planning, estimating and quality control of the company's services.

Mercel J. Shelton, deputy director of the California State Department of Water Resources with headquarters at Sacramento, was elected chairman of the California Section of the American Water Works Association at its annual fall convention in San Diego. **Duncan Blackburn,** chief engineer of the Pasadena Water Department, was elected vice-chairman, and **C. Kenyon Wells,** assistant chief engineer of the Long Beach Water Department, was appointed to the Executive Committee.

Baboobhai V. Bhoota, of Bombay, India, was recently elected a director of Dorr-Oliver (India) Ltd. Dr. Bhoota has been associated with the organization and the sanitary field in India since 1946. He supervises the engineering and installation of all Dorr-Oliver sanitary equipment and processes in India.

William B. Miles, Jr., has joined the staff of Victor W. Buhr Associates, engineers and architects of Salisbury, Md. Mr. Miles was formerly a junior design engineer with the firm of Gardner and Sterling.

Robert B. Brooks, consulting engineer of St. Louis, Mo., received a Distinguished Service Award from the Mississippi River Parkway Planning Commission at its annual meeting held in Davenport, Iowa. The certificate was presented to him in recognition of his work on the Great River Road.

(Continued on page 28)

News of Engineers

(*Continued from page 27*)

Robert W. Stuart of Colonia, N. J., has joined the staff of the Esso Research and Engineering Company's design engineering division. He holds a master's degree in sanitary engineering from Harvard, and was formerly employed as junior engineer with Camp, Dresser & McKee, of Boston.

Howard A. Schroedel, vice-president and director of the Turner Construction Co., New York City, was elected president of the Dartmouth Society of Engineers at its recent annual meeting. Mr. Schroedel is a graduate of Dartmouth, class of 1925 and the Thayer School of Engineering, 1926.

Joseph L. Benson, former supervising rate engineer with the Federal Power Commission in Washington, D. C., announces the opening of consulting offices, specializing in gas and electric rate economics and engineering at 801 Denrike Building, 1010 Vermont Avenue, N. W., Washington 5, D. C.

Joseph S. Ward, consulting soil and foundation engineer of Upper Montclair, N. J., has opened a Soil Testing Laboratory at 48 Notch Road, Little Falls, N. J.

Donald A. Booth is now chief draftsman of the Dravo Corporation's Engineering Works Division in Pittsburgh, Pa. He joined Dravo in 1935 as an estimator and field engineer, and has been assistant chief draftsman since 1954.

Boyd Paul Strain, Jr., is now an instructor in the department of civil engineering at Howard University, Washington, D. C. Mr. Strain has just received a master of science degree in civil engineering from Northwestern University, where he was a teaching assistant in the department of civil engineering.

Albert P. Harness was recently appointed to the staff of the Ohio Contractors Association of Columbus, Ohio. He is serving as assistant to the executive secretary. Mr. Harness was formerly associated with the Jennings-Lawrence Co., a Columbus civil engineering firm.

Charles E. Carver, Jr., has joined the scientific staff of the Woods Hole Oceanographic institution at Woods Hole, Mass., as research associate in hydraulics. Dr. Carver will be primarily engaged in research work on ocean wave phenomena. He was formerly senior hydrodynamics engineer with the Glenn L. Martin Co., of Baltimore, Md.

T. Carr Forrest, Jr., and **James A. Cotton,** of the consulting engineering firm of Forrest and Cotton, announce the relocation of their offices to 600 Vaughn Building, Dallas 1, Tex.

Maurice L. Dickinson, chief hydraulic engineer for the Bechtel Corporation in Los Angeles, Calif., has been elected chairman of the Board of Directors of the Engineers Club of Los Angeles. **Finley B. Laverty,** chief hydraulic engineer for the Los Angeles County Flood Control District and Director of ASCE, was appointed a director.

John W. Gordanier, Captain, Civil Engineering Corps, U. S. Navy, has been ordered to duty with the Commander-in-Chief, Naval Forces, Eastern Atlantic and Mediterranean, with headquarters in London. For the past four years Captain Gordanier has been assigned to the Bureau of Yards and Docks as executive assistant to the Assistant Chief of Bureau for Administration and Personnel and during part of the time also served as director of the Administration Division.

Capt. Gordanier

Claude Latimer, village engineer of Mamaroneck, N. Y., was honored by the village employees at a recent luncheon upon his retirement. Mr. Latimer has served the village more than 25 years, and has been a member of the Village Planning Board for 20 years.

Chester Allen, of Olivet, Mich., is now associated with George E. Snyder, consulting engineer of Jackson, Mich. He is retired head of the civil engineering department at Michigan State University.

Ben C. Gerwick, Jr., president of Ben C. Gerwick, Inc., San Francisco, Calif., announces the relocation of his office to 417 Market Street, San Francisco 5.

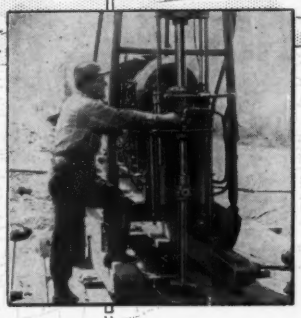
Miles M. Dawson, Brig. Gen., U. S. Army (retired), has been named manager of the newly organized distribution services department of the Westinghouse Electric Corporation at Pittsburgh. As manager of the department, General Dawson will survey the needs and requirements of the company for field storage of finished products.

David H. Wheeler has been appointed air pollution control engineer of the Kaiser Engineers Division of Henry J. Kaiser Company with headquarters in Oakland, Calif. Mr. Wheeler was formerly chief engineer for the Western Precipitation Corporation, Los Angeles, Calif.

Malcolm D. Corner is the new assistant to the vice-president in charge of the assigned product section of U. S. Steel's American Bridge Division in Pittsburgh, Pa. Mr. Corner began his association with U. S. Steel in 1946 and since 1954 has been contracting manager of specialty products for the division.

CONTACT SPRAGUE & HENWOOD, Inc.

FOR ALL OF YOUR DIAMOND DRILLING NEEDS



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Many, many firms throughout the United States and the world know the advantages of core drilling; and Sprague & Henwood, with more than 70 years of experience, is the leader in this field. Sprague & Henwood crews have completed thousands of contracts successfully in every conceivable condition. For the best in exploratory core drilling (surface or underground), blast hole drilling, directional drilling, foundation test drilling, grout hole drilling, and pressure grouting—be sure to call Sprague & Henwood. Estimates and suggestions given without charge.

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IMPREGNATED CORING BIT

"ORIENTED" DIAMOND "TAPER" TYPE NON-CORING BIT

DOUBLE-TUBE REAMING SHELL

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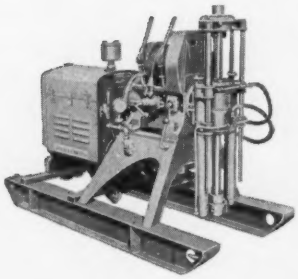
Any bit you buy will work for a while. But if you specify or order Sprague & Henwood "Oriented" Diamond Bits, giving all information on your drilling conditions, you will receive the bit or bits that will do the best job for you. Lower your cost per foot, with a minimum of diamond loss. Write today for complete "Oriented" Diamond Bit Bulletin #320-1.

RESETTING SERVICE

Send in your bits that need resetting, giving full details of results obtained and conditions under which bits were used. They will be returned new—and "Oriented" to give you less diamond loss and lower your cost per foot.

FIELD TESTED DRILLING MACHINES

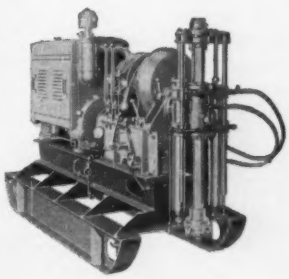


MODEL 40-C CORE DRILL MACHINE

Field Tested means just that . . . with contract work being done under every conceivable condition, Sprague & Henwood drilling machines have to perform right. Different sizes and types to meet various conditions are available. Your conditions should be given in detail, and recommendations will be forwarded to you immediately, without cost.

ACCESSORY EQUIPMENT

In addition to drilling machines, and diamond bits, Sprague & Henwood manufactures and can supply you with a complete line of accessory equipment necessary to make up a drilling outfit, such as drill rods, core barrels, casings, fishing tools, etc. A new and most complete Catalog, No. 400, listing all accessory equipment is available to you. Write today for your free copy. It will be mailed promptly.



MODEL 142 CORE DRILL MACHINE

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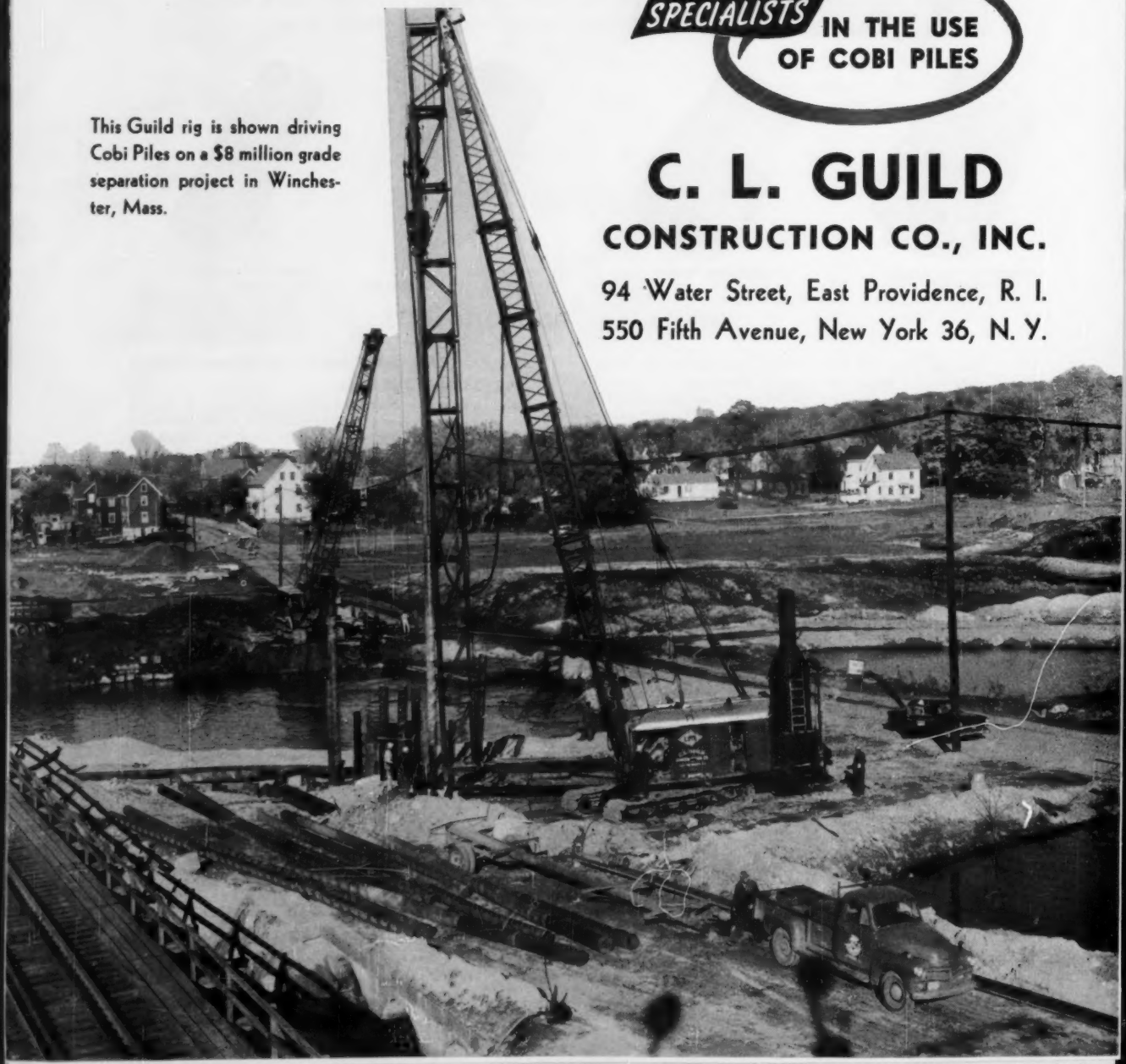
No Matter What the Project... No Matter Where Your Job...

SPECIALISTS IN THE USE OF COBI PILES

This Guild rig is shown driving Cobi Piles on a $8 million grade separation project in Winchester, Mass.



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CONSTRUCTION CO., INC.

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do you know that

For the first time we are assured of having adequate highways? In an important article scheduled for January, AASHO President Rex Whitton shows how the new Federal Aid Highway Act provides the only tool (money) heretofore lacking in attempts to obtain the highways we need. Looking ahead to March, there will be another highway issue—this one with special attention to construction.

Another AASHO road test is in the offing? The important highway article in this issue (page 39) discusses the objectives of the AASHO's third and largest road test (a $14,000,000 undertaking), for which a site is being readied near Ottawa, Ill. The four 7,600-ft test loops embody ultramodern experimental statistical design techniques.

A member of ASCE has been elected governor of Utah? He is George D. Clyde, expert in irrigation and water conservation and a long-time worker in the Society's Irrigation and Drainage Division, which he has served as chairman (item and photo on page 26). The election of Mr. Clyde, a non-political figure, shows growing awareness of the valuable service engineers can render their country in public life.

The Ford Foundation is headed by another member? On October 1 Henry T. Heald, noted engineer educator and former president of New York University, was installed as president of the multi-billion-dollar Ford Foundation. The appointment of Dr. Heald to this important public welfare post is also highly significant, representing as it does the first time one of the foundations has invited an engineer to head it.

A Passamaquoddy power study is under way? Attempts to revive the Passamaquoddy tidal power project—begun and dropped in the thirties—received new impetus this fall with the appointment of Canadian and American boards to study the feasibility of the project. The two boards will deal with fisheries and engineering aspects. The United States has voted $3,000,000 and Canada $300,000 for the studies.

Opportunities exist in all branches of engineering? This is emphasized in the ECPD booklet, "Engineering, a Creative Profession," available now in a third (and new) edition. As a significant index to where the opportunities lie there is a listing of employees of the 633,700 engineers practicing their profession in 1954. To mention a few of these statistics, construction employed 26,300; transportation and public utilities, 28,500; the federal government 52,000; universities, 12,000; state and local governments, 60,000; and active military service, 30,000. About 25,000 were self employed. Copies of the informative guidance booklet are available from ECPD, 29 West 39th Street, New York 18, N.Y., for 25 cents.

Fluoridated water is used in 25 percent of the public supply? The U.S. Public Health Service reports that in the first nine months of 1956 water systems serving 6,000,000 people started fluoridation of their supplies to protect children's teeth. This compares to an average annual increase of 4,000,000 users during the period, 1951–1955. Nearly 45 percent of all communities of over 500,000 are fluoridating their supplies—among them Chicago, Philadelphia, Washington, Cleveland, San Francisco, and St. Louis. New York City is currently weighing the pros and cons.

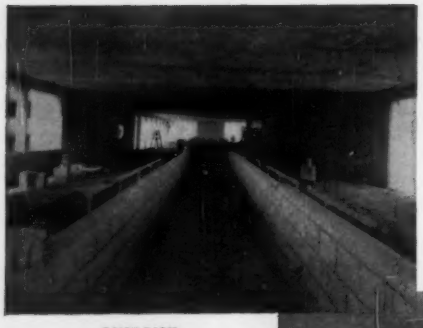
Record job levels continued into October? At 66.2 million in the week ended October 13, total civilian employment was about a million higher than in any previous October on record. The U.S. Bureau of the Census reports that average monthly employment during the first ten months of 1956 was 2,000,000 higher than average monthly employment in the first ten months of 1955, and about 4,000,000 higher than during the first ten months of 1952.

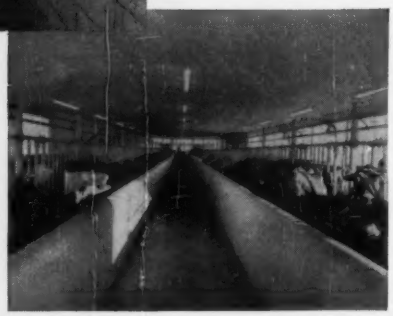
Motorists of the future may enjoy bump-free rides? In the belief that highway expansion joints are unnecessary, several of the states—among them Indiana, Illinois, California, and Texas—have laid down experimental stretches of continuously reinforced concrete pavement. Another stretch is currently being built near York, Pa., under the auspices of the Committee on Reinforced Concrete Research of the American Iron and Steel Institute. Longer pavement life and lower maintenance costs are anticipated advantages, in addition to smoother riding.

The earth satellite is expected to travel at the rate of 18,000 mph? Launched by three-stage rocket, the man-made satellite will be able to circle the earth (at the equator) in less than an hour and a half. This tiny moon—which the United States is launching during the forthcoming International Geophysical Year—will be a hollow sphere, 20 in. in diameter and made of AZ-31 Magnesium Alloy. A solar battery will provide power for the instrument readings. If the satellite can attain a height of 300 miles above the earth, it will remain aloft a year. The construction of the earth satellite is described in a Pittsburgh Convention paper scheduled for the January issue.

Bottoms Up!

Inverted Double-T, Precast, Prestressed 'Incor' Roof Slabs Provide Added Sanitary Feature in 106-Cow Barn





DAIRY BARN
H. W. RUCKS & SONS,
Deerfield Beach, Florida

General Contractor:
DONALD F. GRUBB,
Opalocka, Fla.

Prestressed Members Designed by:
LAKELAND ENGINEERING ASSOCIATES,
Lakeland, Fla.

Members Precast and Prestressed by:
R. H. WRIGHT & SONS, INC.
Ft. Lauderdale

Members Installed by:
POSTON STEEL ERECTORS, INC.
Ft. Lauderdale

● Here is a unique barn, recently completed for a progressively-minded dairyman who wanted the advantages of all-concrete construction, including a ceiling that is easy to keep meticulously clean. The designer came up with the economical answer by installing precast, prestressed double-T roof slabs *upside down*.

To provide a clear, unobstructed milking area in this 106-cow barn, a total of 55 double-T prestressed roof slabs, lengths up to 37½ ft., widths up to 4 ft., were installed in inverted position. Slabs of somewhat smaller dimension were placed in conventional position over the adjoining milk-processing and feed-storage rooms.

The entire roof, pitched 6 in. toward the rear for drainage, was covered with built-up roofing.

This building, with 13,000 sq. ft. of space, all usable, cost $52,000 complete. The inverted roof in place cost $1.35 per sq. ft., or about 40¢ more per sq. ft. than the upright double-T roof.

Roof members were fabricated under factory-controlled conditions in the casting yard, using 'Incor'* 24-Hour Cement for the assembly-line speed and precision which spell utmost economy in fabrication. Smooth concrete ceiling surfaces reflect the workability and all-around quality of America's FIRST high early strength portland cement, providing an added measure of sanitation in a truly modern barn. *Reg. U.S. Pat. Off.

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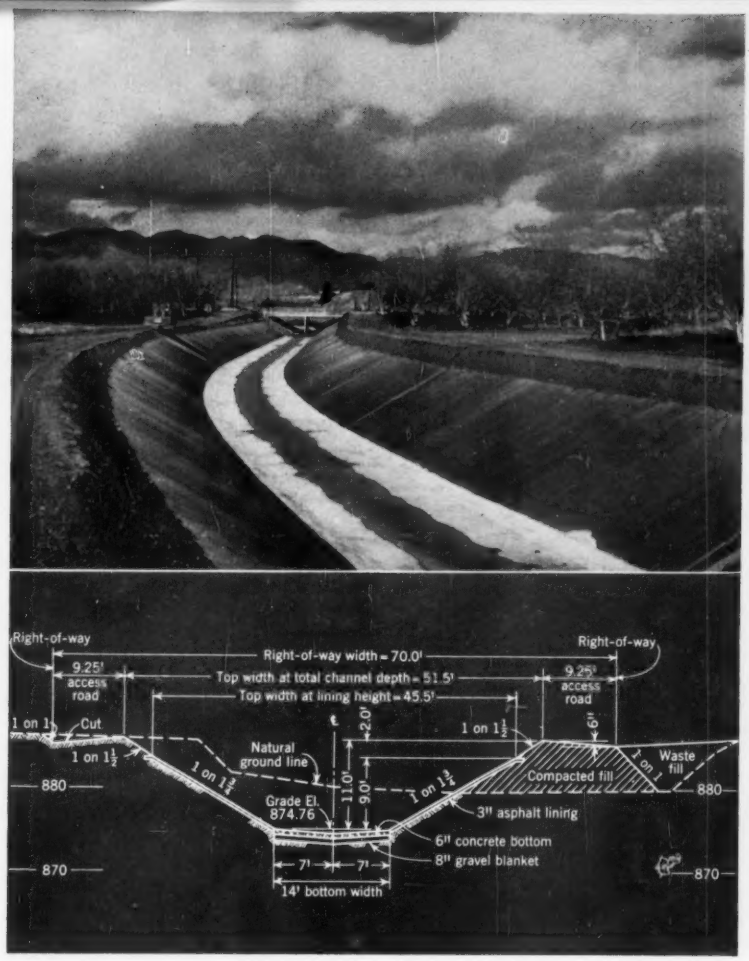


Asphaltic-concrete slope paving on last section of Bull Creek flood channel completed was placed for $0.18 per sq ft, including placement of reinforcing.

FIG. 1. Bull Creek flood channel has trapezoidal section.

FLOOD CHANNEL paved with asphaltic concrete

LOUIS R. HOVATER, J. M. ASCE, Area Engineer, The Asphalt Institute, Los Angeles, Calif.

Bull Creek, a meandering natural drainage ditch in the San Fernando Valley, has been lined for a distance of about $5^1/_2$ miles using asphaltic concrete for the slope lining and portland-cement concrete for the invert lining. This creek is a vital segment in the series of channels designated to eliminate floods in the Los Angeles area. Its location is of particular significance because the San Fernando Valley is one of the fastest growing areas in the United States. Residential subdivisions and industrial installations are increasing so rapidly that many flood channels are needed to carry off runoff during rain storms.

Bull Creek begins near the San Fernando reservoirs of the Los Angeles Department of Water and Power and runs south for about 7 miles to the Sepulveda Basin formed by the Sepulveda Dam, a flood control structure built by the Corps of Engineers. The Bull Creek channel has now been lined from the Sepulveda Basin north for a distance of about $5^1/_2$ miles, leaving only $1^1/_2$ miles unlined.

The channel section for all the contracts is similar in shape, changing only in dimensions. It is trapezoidal, as shown in Fig. 1. The slope lining consists of a 3-in. thickness of asphaltic concrete, which was placed on the compacted subgrade in the case of fill sections and on the natural subgrade in the case of cut sections. The invert lining, placed on an 8-in. gravel blanket, consists of portland-cement concrete 6 in. thick. Table I gives hydraulic data on the two sections of lining completed under the last contract.

Slope-paving machine, developed by paving contractor, utilizes screw conveyor to distribute hot mix over full width of slope. Note fencing used as reinforcing ahead of machine. Truck running on channel berm pulls machine along by means of cables attached to its front corners.

The channel invert varies from 14 to 16 ft in width, and the vertical height of the lining varies from 9 to 11 ft. The side slopes are $1^3/_4$:1.

The 3-in.-thick slope lining was specified to have a minimum specific gravity of 1.92 (a density of 120.0 lb per cu ft) and to conform to the following gradation:

Sieve Sizes	Total Passing, % by Weight
No. 3	100
No. 10	65–80
No. 40	30–40
No. 100	14–22
No. 200	6–12

To the aggregate, graded as shown above, 8 to 10 percent by weight of 85-100 penetration asphalt cement was added as a binder.

Slope paving machine used

The paving contractor designed a slope-paving machine for laying the asphaltic concrete lining in a continuous ribbon on one side of the channel. The machine was skid-mounted at the bottom of the slope so that its weight would be supported by the invert lining, and it was pulled forward by a truck running along the channel berm. At the top of the slope, it was attached to a side loader which fed the hot asphalt mix to it. Trucks carrying the hot mix traveled the channel berm and unloaded into the side loader.

Initial compaction of the hot mix was accomplished by a steel-wheel roller attached to the paving machine and operating parallel to the invert. Final compaction of the asphaltic concrete slope lining was accomplished by another steel-wheel roller, which was attached to a rubber-tired tractor running along the channel invert, as shown in a photograph. With this roller, the slope was rolled at right angles to the invert from the bottom to the top and back down. This procedure was necessary because the tractor could not pick up the roller when it was at the top of the slope. When the roller was at the bottom of the slope, however, the tractor could pick it up and move it along to its next position.

An unusual feature of the slope lining is that it is reinforced with Ellwood Type F fencing, embedded in it at mid-depth. This reinforcing is used to furnish a basket-like restraint to the lining in case of subgrade movement or settlement, and to prevent undercutting.

To hold the reinforcing mesh in place on the slope, discarded boiler tubes were driven in along the top of the slope. These tubes, $2^1/_4$ in. in outside diameter and 4 ft in length, were driven at 8-ft intervals to such a depth that 2 in. projected above the subgrade. The reinforcing was laid on the slope parallel to the channel line and so placed that the triangles at the edge of the fencing would fit around the projecting ends of the boiler tubes. The lower edge of the fencing was tied to No. 9 anchor wires at the edge of the portland-cement-concrete invert lining.

One contract remains to be let for lining the remaining $1^1/_2$-mile length of the Bull Creek channel. For this a similar channel section and the same type of lining will be used.

The Soil Conservation Service and the Los Angeles County Flood Control District have had the responsibility of improving Bull Creek. The W. F. Maxwell Company of Los Angeles was the prime contractor for the last section of lining completed. This company installed 247,177 sq ft of 3-in.-thick asphaltic concrete slope lining and placed the fencing reinforcing at a bid price of $0.18 per sq ft. The fencing was furnished to the contractor. The Hermreck & Easter Company of Santa Maria, Calif., were the subcontractors for paving and earthwork.

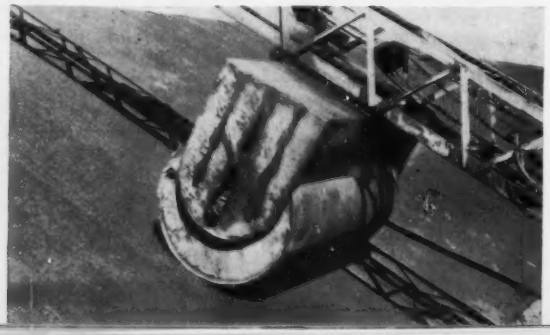
Bill R. Bruner is District Conservationist, and Charles F. Bond is Project Engineer for the Soil Conservation Service, which has offices in San Fernando, Calif. H. E. Hedger, M.ASCE, is Chief Engineer for the Los Angeles County Flood Control District.

TABLE I. Design data for last two sections of Bull Creek channel completed

	Section A	Section B
Channel length, ft	675	6,975
Depth of slope lining, ft	9.3	9.0
Normal flow depth, ft	7.18	6.97
Bottom width, ft	16.0	14.0
Value of n	0.015	0.015
Value of s, ft per ft	0.0080	0.0080
Value of VR, fps	24.37	23.56
Value of Q, cfs	5,000	4,300

Rubber-tired tractor-roller is used for final compaction of side slopes. Dirt covers invert lining, which is of portland-cement concrete 6 in. thick.

Roller made two passes over asphaltic-concrete slope paving and then was moved ahead at toe of slope. Note dense texture of slope lining.



JUNIOR MEMBER ORGANIZATIONS PLAY VALUABLE ROLE

WILLIAM J. CARROLL, J.M. ASCE

Civil Engineer, James M. Montgomery, Consulting Engineer, Pasadena, Calif.

The question here being considered is whether there is a need, within our larger Local Sections or their Branches, for a separate Junior Member organization. Whenever this question arises, or some phase of it is discussed, two major objections to the separate type of Junior organization are generally made. The first runs something like this:

"Any young engineer that is interested in the profession will get out on his own and attend Society functions. If he doesn't do it on his own, he is not the type of rugged individual that is the backbone of our Society and hence is not worthy of any help."

The second objection is somewhat milder:

"A separate Junior organization tends to create a schism between the Junior Member and the rest of the Society rather than to integrate him into the Society group. It sets up an organization which competes for the young engineer's time and keeps him away from the main activities of the Section."

Both these objections have some merit under certain limited circumstances, but generally speaking both have rather serious flaws. When these flaws are understood, the need for separate Junior Member organizations in large metropolitan areas will be evident.

In answer to the first argument, it must be remembered that, for the Society to develop and put into effect a program, it must first find means of arousing the interest of its members, and hence of securing their participation in its affairs. To do this it is necessary to have a definite plan. There must be more jobs and fields of endeavor for more people. The young engineer has to be made to feel that he is participating in the activities of the Society and that he does belong to the organization. To leave him high and dry with the statement that, if he is interested in his profession he will become active, without showing him how he can become active, is not the way to do this.

The "rugged individual" philosophy may be all right for a limited postwar period, when the new graduates are older men with a good realization of what they consider important and a good idea of how to go about getting it. Most young graduates, however, come out of school with no wartime experience to mature them, and with only the background of their Student Chapter to give them an idea of the Society's aims and activities. The picture is therefore one of help needed and needed badly.

These young graduates do not know the Society. What knowledge they do have of the professional aims of the Society has been "book-read" to them by their faculty advisers and other Section members. This is not meant in a derogatory sense, because I believe that the influence of these advisers is a fine thing. But if help is not proferred these young men, if they are not put to work on Society affairs, if they are not given the ASCE picture in the common language of engineers of their own age, they may soon become lost as far as the professional aspect of engineering is concerned.

Surely any program that does not cultivate the interest of the Junior Member is not in the best interest of our Society. Many organizations are competing for the young engineer's time. If he is the "rugged individual" type he has, besides his work and family, organizations such as junior chambers of commerce, service clubs, and other civic enterprises, requesting a large share of his time. Such organizations have laudable programs and participation in them by engineers is commendable and should be encouraged. But at the same time the young engineer should be encouraged not to neglect his own profession and his opportunities for eventual leadership in its affairs.

As for the second argument—that separate Junior Member organizations create schisms instead of encouraging integration—this probably would be true only where the Section membership is small, and hence where there are enough jobs so that the Junior Member can become a part of the Section's working organization without expansion of its scope. I would like to emphasize the words "working organization." As far as integration is concerned, it doesn't do any good to appoint Juniors to non-working committees and hope that they will become integrated. In such cases the effect will be adverse and the young engineer may never be able to obtain a true understanding of the professional aspects of his own profession.

In small Sections and Branches, where the activities can successfully include the younger engineers, it is not proposed that separate Junior Member organizations be formed. However, it is hoped that such organizations will be formed in the larger metropolitan areas where they can be of benefit, will provoke interest, and will accomplish results commensurate with the aims of the Society.

Worthwhile projects assigned

I know that the existence of a separate Junior organization within the Los Angeles Section has never resulted in any schisms or difficulties between the Juniors and the Section. In fact, the Los Angeles Section has assigned many worthwhile projects to the Junior Member Forum, allowing the Section more time to concentrate on other matters that could not be undertaken without a working Junior organization to carry some of the burden. Examples of projects turned over to the Junior Members this past year are:

1. A study and report on the resolution of the Nebraska Section relative to the Restoration of a Separate Professional Classification in the federal Civil Service system.
2. The collection of information for the Committee on Employment Conditions asked for by Past-President Glidden in May 1955, such information to cover everything on labor laws and court decisions affecting unionization and collective bargaining in California along with any other information available on the economic and political factors bearing on the enforcement or application of such laws.
3. The presentation of panel discussions at the sessions of the Department of Conditions of Practice at the ASCE Convention in San Diego in February 1955, and at the Pacific Southwest Conference in Los Angeles in April 1956.

Such projects are worth while and they develop the professional aspect of engineering for the young engineer. They tend to keep him in a "working organization"—the very thing he needs to be integrated successfully into a unified engineering family.

The idea of unity in the engineering profession is an important thing to the young engineer. One of the things he

feels necessary is to acquaint himself with the work of the younger engineer organizations within each of the other Founder Societies, and hence to do his part to help create a unified profession.

I would like to quote from an address, "EJC Builds National and Regional Unity in the Engineering Profession," presented by Carlton Proctor, Past President of ASCE, before the Professional Cooperation Luncheon at the 1955 Annual Convention. Mr. Proctor stated:

"Widespread interest in the recently established provision for affiliate membership in EJC and the increasing demand for such affiliate membership are healthy manifestations of the engineer's growing realization that he is more than a scientific technologist, more important to society than a technician providing his knowledge and experienced judgment in fields of applied science. He has awakened to the fact that he must unite with engineers in other branches of the profession so that he can fulfill his obligations to mankind, and finally reach the professional and ethical status he has long sought."

This has been done in the Los Angeles area, with the Los Angeles Council of Engineering Societies becoming the first affiliate of Engineers Joint Council. (The Council consists of the Founder Society organizations within the Los Angeles area plus a structural engineers' group.) However, this "unity endeavor" has also been encouraged at the younger engineers' level by organizing a Young Engineers Committee within the framework of the Los Angeles Council. This committee consists of delegates from younger engineer groups of the ASME, AIME, AIEE, and ASCE, as well as from the AIChE.

This idea of unity among younger engineers is mentioned to show that where a separate Junior Member organization exists, the possibilities of doing some constructive work for the professional betterment of the engineer multiplies many fold. Where a Section might say that there is not enough work for a separate Junior Member organization, they might now ask, "Are we fully realizing all our potentialities? Are we doing everything we should? Could not an organization of Junior Members eager to participate in their profession work on things that we as yet have left undone?"

Just what is a Junior Member organization? Within the 74 Sections of the Society there are now nine Junior Member Forums. These are in the Cleveland, National Capital, Los Angeles, Metropolitan (New York), Northwestern (most of Minnesota, all of North and South Dakota), Philadelphia, Pittsburgh, Sacramento, and San Francisco Sections.

Since I am from the Los Angeles Section, I will confine my remarks principally to the structure of the Junior Member Forum of that Section. The purposes of the Forum as set forth by its constitution are rather simple:

"To stimulate the interest of the members in the affairs of the American Society of Civil Engineers and of the Los Angeles Section; to prepare the members for active participation herein by: (1) Providing opportunity for experience in parliamentary procedure and in the presentation of papers, (2) developing initiative and leadership, and (3) affording opportunity for close association and interchange of knowledge and opinions."

Other forums have similar purposes, all of which I believe can be stated basically as "to stimulate the interest of the younger engineer in the affairs of the Society, at both the national and local level."

The membership of the Forum consists of all Junior members of the Los Angeles Section and of all members of the Student Chapters within the Los Angeles Section area. Voting privileges are restricted to those of Junior Member grade. The officers are a president, two vice-presidents, a secretary, and a treasurer. These officers together with the last Forum past-president, who is still a member of the Junior Forum, and an Adviser, make up what is called the Executive Council. The Executive Council is the principal governing body of the Forum. Aiding the Executive Council are some 15 committees which are rather diversified in their fields of endeavor (Table I).

There were 30 Junior Members in the administrative structure of the Forum in 1956. As can be seen from Table I, some of the committees such as the Year Book Committee and the Ladies Night Committee, undertake tasks that are for the direct benefit of the complete Section. Others, such as the Program Committee and the Banquet Committee, work primarily for the Junior Members. Most of the other committees correspond directly to the main Section committees, the chairman of the Junior Member committee being a member of the corresponding Section committee in each case. Using this type of committee membership, with verbal monthly reports from the chairman to the Executive Council of the Forum, the complete Junior Member Forum administration of some 30 Junior Members is kept informed of all Section activities. We consider that this knowledge of the Section's activities is an important factor in educating ourselves in the affairs of our Society.

TABLE I. Los Angeles Section Junior Member Forum

Officers and Committees for 1956

JAMES R. DAVIS, *President*
WILLIAM J. KEENER, *1st Vice President*
LAWRENCE A. COLEMAN, *2nd Vice President*
HARRY BLANEY, JR., *Secretary*
RONALD B. MYERS, JR., *Treasurer*
N. D. WHITMAN, JR., *Forum Adviser*

Committees

BANQUET COMMITTEE
Bruce Glidden

CONSTITUTION & LEGISLATION COMMITTEE
Jack Estridge

ENGINEERING EDUCATION COMMITTEE
Bob Chipman

FIELD TRIP COMMITTEE
Philip Benton

LADIES' NIGHT COMMITTEE
Rod Lundin

MEAD CONTEST COMMITTEE
Lyle N. Hoag, Jr.
Larry Coleman

MEMBERSHIP COMMITTEE
Robert A. Schaak, *Chairman*
Walter Babchuk
Arthur Gunlaugson
Gene Swanson

NOON LUNCH COMMITTEE
Gene Rheault

PUBLICITY COMMITTEE
Louis Hovater

PROGRAM COMMITTEE
Kenneth Mullen, *Chairman*
Norbert Weinberg

RECEPTION COMMITTEE
Jerry Carlat
Bob Clawson

SALARY COMMITTEE
Philip Abrams, *Chairman*
Arthur Bruington
William J. Carroll
Bob Davis
Hodge C. Gaines
Mal Horton
William J. Keener
Bob Lawson

STUDENT CHAPTER ADVISERS
Hodge C. Gaines
Lyle Hoag

WAYS & MEANS COMMITTEE
Bill Moffitt

YEARBOOK COMMITTEE
Bob Clawson
Robert Y. D. Chun
Hodge C. Gaines
Claude W. Hewitt

The regular meetings of the Forum are held at the same location and just prior to the Los Angeles Section dinner meetings. Such a procedure has been found to hold most of the Junior Members for attendance at the Section's regular monthly meetings. Other forums, such as those of the Metropolitan and San Francisco Sections, hold their meetings separately, on a night different from that on which the parent Section meets.

In closing, I would like to emphasize what I believe to be the principal advantage of a separate Junior Member organization in a large Section. This is the advantage of giving the Junior Member work to do—of making enough useful jobs available so that the young engineers will develop the interest to participate in the affairs of the profession. Through this means ASCE will promote the feeling that all its membership is interested in all its activities. A basic part of the ASCE program for the development of member interest in professional affairs should be an enlarged and more active Junior Member program.

(This article is based on Mr. Carroll's panel discussion presented at the ASCE Dallas Convention, before the Conditions of Practice session presided over by Frank L. Weaver, chairman, and by Glenn W. Holcomb, vice-chairman, of the Society's Department of Conditions of Practice.)

Large-scale highway research—AASHO Road Test

FRED BURGGRAF, M. ASCE
Director, Highway Research Board, Washington, D. C.

W. B. McKENDRICK, Jr., M. ASCE
Project Director, AASHO Road Test, Highway Research Board, Washington, D. C.

Site preparation is already under way for the third and largest road test undertaken by the Highway Research Board for the state highway departments. This test, known as the AASHO Road Test because it is sponsored by the American Association of State Highway Officials, draws on the experience acquired from the two previous tests, supplemented by the latest scientific principles of statistical experimental design and the most recent developments in electronic instrumentation and data analysis. We are confident that this scientifically planned project will produce a great deal of information that will be essential to future highway engineering and transportation.

This $14,000,000 highway research project is being financed cooperatively by the state highway departments, the Bureau of Public Roads, the Department of Defense, the Automobile Manufacturers' Association, and other allied sectors of industry. The test area, on which grading has recently been completed, is near Ottawa, Ill.

The first half of the twentieth century witnessed the greatest revolution in transportation in the history of the world. Man's foremost invention, the wheel, was put to full use. All forms of transportation progressed greatly, but none so rapidly and spectacularly as the motor vehicle. From a very meager beginning at the turn of the century, when there were few vehicles and a horse-and-buggy highway system, the highway industry with all its many and varied facets grew until it now encompasses over 60 million vehicles, over 3 million miles of highways and streets, and a myriad of connected businesses that reach into every part of our land.

Highway research through these years struggled valiantly to keep pace with ever-changing industry. The first large-scale highway research project of note was the Bates Road Test in Illinois in 1921. This test established some principles of design of roadways that are still valid and in force today. A report of this project was made to the American Society of Civil Engineers by Clifford Older, and is recorded in the ASCE *Transactions*, Vol. 87, 1924. For years afterward practically all highway research was on a small scale and was conducted by individual states, Bureau of Public Roads (BPR), universities, industry, or some combination of these.

After World War II, the much faster growth of the industry began to change the thinking and concepts of highway administrators and engineers throughout the country. Soil mechanics was in its infancy; many new ideas and concepts were being tried in roadway pavements; and with it all, the highway engineer was finding that there were many things he needed to know.

First came the Maryland Road Test at LaPlata, Md., planned by the Interregional Council on Highway Transportation and sponsored by a group of northeastern and north central states, the BPR, and members of the truck-manufacturing and petroleum industries. Its total cost was $250,000. (See Road Test One-MD, Special Report 4, Highway Research Board, Washington, D. C.)

Next came the WASHO Road Test at Malad, Idaho, planned by the Western Association of State Highway Officials (WASHO) and Alaska, with financial assistance from BPR and members of the truck-manufacturing and petroleum industries. (See articles by W.N. Carey, Jr., A.M. ASCE, in CIVIL ENGINEERING for October 1953 and January 1956; also WASHO Road Test, Parts 1 and 2, Special Reports 18 and 22, Highway Research Board, Washington, D.C.) The cost of this project was $900,000. Thus the base of large-scale road tests had broadened to become regional. Both these projects were under the jurisdiction of the Highway Research Board.

The Mississippi Valley Conference of State Highway Officials was to sponsor the next road test, and it was during the planning stage for this project in 1951, that the idea was conceived of conducting a road test on a national scale. From this was born the AASHO (American Association of State Highway Officials) Road Test. In spite of its total cost, estimated at 14 million

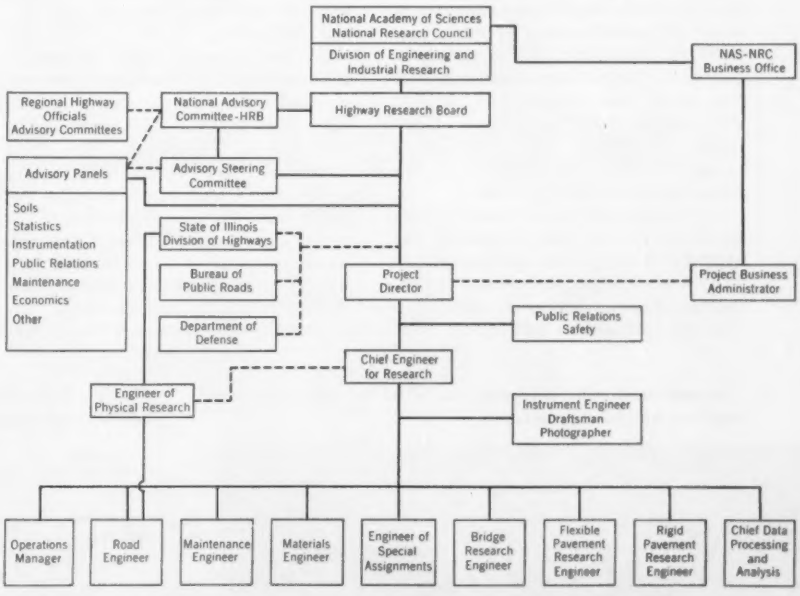


FIG. 1. Organization chart shows personnel set-up for AASHO Road Test.

Westerly end of Loop D has turn-around with radius of 200 ft. Test tangents are about 50 percent complete.

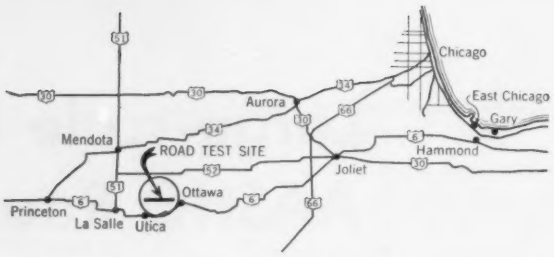


FIG. 2. AASHO Road Test Project is located in Illinois, on U.S. 6, between Ottawa and Utica.

dollars, there will still remain, after this extensive research project is completed, unsolved problems on which still further research will be needed.

The AASHO Road Test is primarily a study of pavement behavior when known load and load frequencies are applied. In the four major loops, the most modern scientific statistical experimental design techniques have been used, thus assuring a maximum of effective information from a minimum number of test sections. Since there are 836 individual test sections in the Road Test, and since one or more observations per test section will be made per day, it is evident that the data to be collected and analyzed will reach staggering proportions. Therefore it is important to eliminate the collection of all unnecessary data.

Origin and history of project

Early in 1950, the AASHO formulated plans for a series of accelerated traffic loading tests on highways. In the ensuing discussions, there was evidence of support for a road test of expanded scope, to include both rigid and flexible pavement, with the cooperation of both industry and government. The Highway Research Board was requested to study the matter and to prepare a proposal recommending the scope and a general outline of a large-scale road test. The report was completed in October 1951 and the Road Test Advisory Committee of AASHO was authorized to proceed with the development of the comprehensive road test idea.

In December of 1951 a Working Committee to act as a subcommittee of the Highway Transport Committee of AASHO was appointed to prepare a prospectus of the project, locate a construction site, prepare an estimate of cost, and establish financial responsibility. Representation on the Working Committee consisted of states representing the four Regional Associations of Highway Officials, Canada, the BPR, the Highway Research Board, Department of the Army, Asphalt Institute, Portland Cement Association, Automobile Manufacturers' Association, American Trucking Association, and National Highway Users Conference.

The Working Committee's preliminary statement was transmitted to the states and industry in July 1952, requesting their participation in the project. At the same time, the AASHO Highway Transport Committee, by formal resolution, approved the Ottawa, Ill., site recommended by the Working Committee. In December 1953, a revised estimate of cost, based on a full two-year test on four loops with 48 vehicles plus 8 stand-by units, was submitted to the Highway Transport Committee. At the Seattle National meeting in November 1954, the AASHO approved the construction of the AASHO Road Test Project.

On February 22, 1955, a joint meeting of the Executive Committees of AASHO and of the Highway Research Board was held to discuss financing and several other phases of the proposed road test. The financing plan ultimately developed was a contractural agreement executed between each state highway department and the BPR covering the fiscal side of the project. This fiscal agreement provides that BPR, acting as the state's fiscal agent, will pay the state's share of the estimated cost of the project direct to the Highway Research Board, the money to come from the $1^1/_2$ percent highway planning survey funds allocated to the respective states. After the Highway Research Board submits certified vouchers of expenditures, BPR will advance the funds. Also at this meeting, the Executive Committee of the Highway Research Board accepted the administrative responsibility for the project after receiving a formal request for such participation from AASHO'S Executive Committee.

Regional and National Advisory Committees organized

As soon as the Highway Research Board received from the BPR the names of the states which had executed agreements with the latter to participate in the Road Test, letters were sent to the chief highway engineer of each state asking him to name the most qualified representative in his department to serve on one of the four regional advisory committees. After these representatives were notified of their appointment by the Board, the vice presidents in each of the four AASHO Districts then conducted a poll among the regional representatives to select three to serve on the National Advisory Committee for the project. This procedure was necessary to keep the size of the National Advisory Committee within practical working limits. This poll was completed on January 12, 1956.

Well in advance of any scheduled meeting of the National Advisory Committee, all members of the Regional Advisory Committees receive copies of all prepared material to be considered at the meeting. Thus each regional member can convey his advisory comments to the National Committee through his Regional Chairman.

In addition to the representatives from the four regional districts of AASHO, the National Committee includes competent representatives from other disciplines approved by the Exec-

Pneumatic-tired roller compacts 4-in. lift of soil embankment on west turn-around of Loop D.

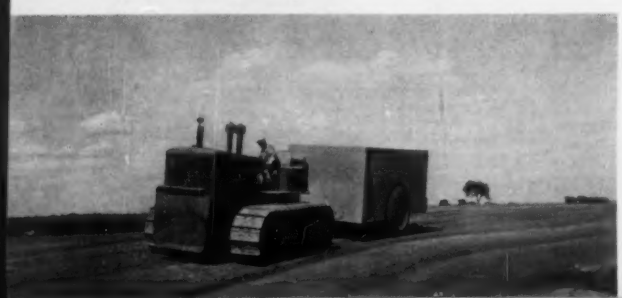
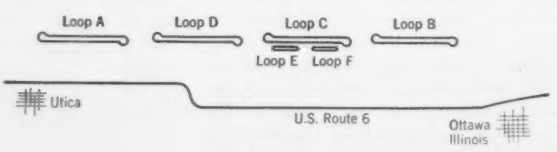


FIG. 3. Schematic layout shows test loops, which will be connected at conclusion of tests, to form new four-lane highway.



utive Committee of the Board. The 33 members of the National Advisory Committee are given in Table I. From the National Advisory Committee, a Steering Committee was appointed to provide guidance in the periods between meetings. The chairman of both committees is Prof. K. B. Woods, M. ASCE, of Purdue University.

Another feature of the organizational set-up is a series of technical advisory panels dealing with such subjects as statistics, soils, instrumentation, bridges, materials and construction, economics, public relations, and maintenance.

The National Advisory Committee has held three meetings this year, the Regional Advisory Committees a number of meetings, and five of the Advisory Panels are functioning. The work of these groups is outstanding, and the value of their advice and counsel is immeasurable.

Construction at site

The Illinois Division of Highways is handling the design, right-of-way acquisition, and construction at the site—the latter through normal contractural arrangements. All other phases of the project, including the on-site testing for the construction work, are being handled directly by the Highway Research Board.

To accomplish its part of the work, the Illinois Division of Highways established a task force at Ottawa near the test site. The number of engineers and engineering aids in this office has varied from 9 to 16 during the surveying, design, and construction stages to date. Additional engineers and technical personnel in Springfield, and in the Illinois District 3 office in Ottawa, prepared the construction specifications, worked on the design of the several bridges that are required in addition to the test bridges, and conducted right-of-way negotiations. All this work is being correlated by W. Emmett Chastain, Sr., Engineer of Physical Research of the Division's Bureau of Research and Planning. Mr. Chastain also represents Chief Engineer Ralph R. Bartelsmeyer on all matters relating to the road test.

Rotary speed mixer adds water to, and processes, 6-in. loose layer of soil on grade of west turn-around of Loop D.

TABLE I. National Advisory Committee of Highway Research Board for AASHO Road Test

K. B. Woods, M. ASCE, *Chairman*
Professor and Head, School of
Civil Engineering, Purdue University, and
Chairman, Highway Research Board

A. A. Anderson, M. ASCE
Chief Highway Consultant
Portland Cement Association

Ralph R. Bartelsmeyer
Chairman, AASHO Highway Transport Committee, and
Chief Highway Engineer
Illinois Division of Highways

D. Kenneth Chacey
Special Assistant for Transportation Engineering
Office of Chief of Transportation
Department of the Army

W. E. Chastain, Sr.
Engineer of Physical Research
Illinois Division of Highways

Harold F. Clemmer, M. ASCE
Engineer of Materials and Standards
District of Columbia Department of Highways

Ralph E. Fadum, M. ASCE
Professor and Head, Civil Engineering Department
North Carolina State College

E. A. Finney, M. ASCE
Assistant Testing and Research Engineer
Michigan State Highway Department

H. A. Mike Flanakin, M. ASCE
Highway Engineer
American Trucking Associations, Inc.

Carl E. Fritts, M. ASCE
Vice President for Engineering
Automotive Safety Foundation

Sidney Goldin
Assistant to Marketing Vice President
Shell Oil Company
(Rep. Petroleum Industry)

E. L. Hollifield
Engineering Staff
Ford Motor Company

E. H. Holmes
Deputy Commissioner
Bureau of Public Roads

Walter C. Hopkins, M. ASCE
Deputy Chief Engineer
Maryland State Roads Commission

John B. Hulse
Managing Director
Truck Trailer Manufacturers' Ass'n

Francis N. Hveem, A.M. ASCE
Materials and Research Engineer
California Division of Highways

A. E. Johnson, M. ASCE
Executive Secretary
American Association of State Highway Officials

Roy E. Jorgensen, M. ASCE
Engineering Counsel
National Highway Users Conference

Miles S. Kersten, A.M. ASCE
Associate Professor
University of Minnesota

J. L. Land, M. ASCE
Chief Engineer
Bureau of Materials and Tests
Alabama State Highway Department

R. E. Livingston
Planning and Research Engineer
Colorado Department of Highways

L. C. Lundstrom
Assistant Director
General Motors Proving Ground

Burton W. Marsh, M. ASCE
Director, Traffic Engineering and Safety Department
American Automobile Association

R. A. Moyer, A.M. ASCE
Research Engineer and Professor
Institute of Transportation and Traffic Engineering
University of California

Lawrence K. Murphy, A.M. ASCE
Construction Engineer
Maine State Highway Commission

R. L. Peyton, A.M. ASCE
Engineer of Research
State Highway Commission of Kansas

T. E. Shelburne, M. ASCE
Director, Highway Investigation and Research
Virginia Department of Highways

George M. Sprowls
Manager, Highway Transportation Dept.
Goodyear Tire and Rubber Company

H. O. Thompson
Testing Engineer
Mississippi State Highway Department

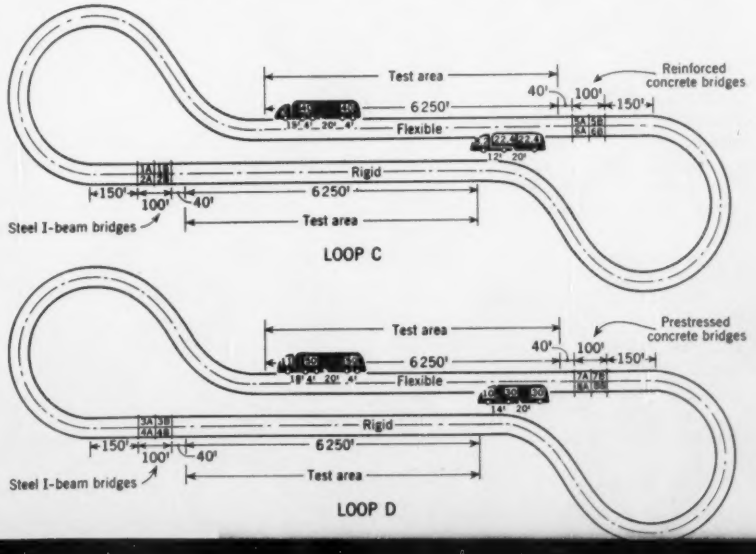
Arvin S. Wellborn, M. ASCE
Chief Engineer
The Asphalt Institute

Rex M. Whitton, M. ASCE
President, AASHO, and
Chief Engineer
Missouri State Highway Department

W. C. Williams, M. ASCE
State Highway Engineer
Oregon State Highway Department

J. C. Young, M. ASCE
Chairman, AASHO Committee on Design, and Engineer of Design
California Division of Highways

FIG. 4. On Loops C and D trucks with various axle loads (shown in kips) will traverse sections of flexible and rigid pavement. Note location of steel I-beam test bridges.



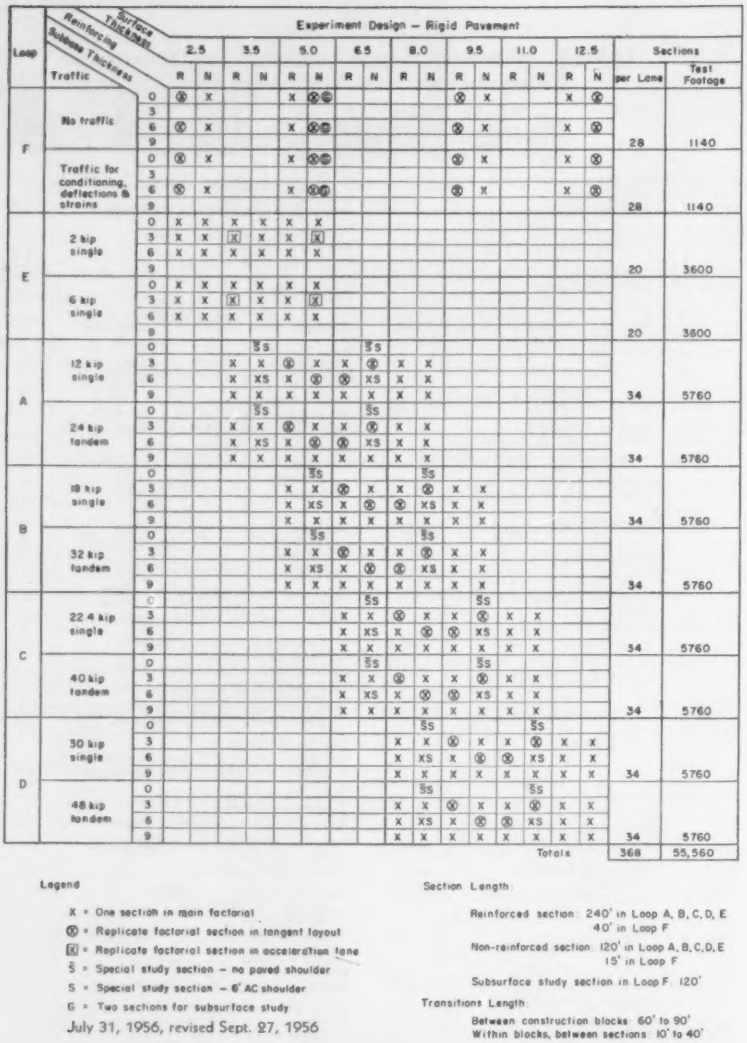


TABLE II. Descriptive data for 368 sections of rigid pavement

Organization at test site

Beginning in the early summer of 1955, the Highway Research Board started to organize for the gigantic task ahead. First on the scene was W. N. Carey, Jr., A.M. ASCE, Chief Engineer for Research. This was in August 1955. The staff grew slowly, working on the plans for quarters for the staff group, the experimental design, and many other aspects of the project. In April 1956, Project Director W. B. McKendrick, Jr., M. ASCE, former chief engineer of the State Highway Department of Delaware, was appointed.

The organization for the project, which appears in Fig. 1, is on a functional basis. There are 11 branches, each headed by a branch supervisor: public relations, instrumentation, vehicle operations, construction, maintenance, materials laboratory, special assignments, bridge research, flexible pavement research, rigid pavement research, and data processing and analysis. The Highway Research Board has secured well qualified people to fill these top posts.

Both flexible and rigid pavement tests

The test is to be made on a four-lane divided highway which is to become a part of an eight-mile relocation of U.S. 6 near Ottawa, Ill., after the test is completed. The geographical location of the project and the layout of the test loops are shown in Figs. 2 and 3. The four main test loops each consist of 6,600-ft test sections of divided roadway connected at each end by a turn-around of 200-ft radius. The total distance around each loop is 3.1 miles.

The newly enacted Federal Highway Bill (1956) recognizes the AASHO Road Test and requires an interim report to Congress on it in March 1959. To comply with some of the Congressional requests for additional information, a fifth loop was added for light vehicles. This loop is approximately 5,000 ft in length and is located adjacent to one of the main loops on land acquired in connection with the main right-of-way. For special studies there is another auxiliary loop approximately 2,200 ft long, located nearby.

Half of the test pavements will be of rigid type (non-reinforced and reinforced concrete) and the other half will be of flexible type (asphaltic concrete). The project also includes 16 test bridges —eight of steel-girder construction, four of conventional concrete, and four of prestressed concrete. These will be built in the loops carrying the four heaviest axle loads, as indicated in Fig. 4. See also Table IV.

Truck-tractor semi-trailers and smaller two-axle vehicles will be used as the test vehicles. These vehicles will be loaded to provide, on the single-axle types, loads of 2,000, 6,000, 12,000, 18,000, 22,400 and 30,000 lb, and on the tandem axle types, loads of 24,000, 32,000, 40,000, and 48,000 lb. Loads will be applied for a period of two years. More than a million axle loads will be applied on each test section. The vehicles will be driven at approximately 30 mph, around the loops in the direction of normal traffic, applying the single axles on the inside lanes and the tandem axles on the outside lanes. They will operate 18 hours a day and 6 days a week. Each loop will have two test lanes with concrete pavement on one side of the dividing strip and bituminous pavement on the other side.

The portland-cement-concrete slabs will be varied from $2\frac{1}{2}$ to $12\frac{1}{2}$ in. in thickness. Some of these slabs will be placed directly on the soil, but the large majority will be laid on a granular subbase varying in thickness from 3 to 9 in. Both plain and reinforced concrete will be used. The experimental design, as now set up, includes 368 sections of rigid pavement, described in Table II.

The asphaltic concrete surfacing of the flexible pavements will vary in thickness from 1 to 6 in., and these surfaces are to be laid on various combinations of base and subbase thicknesses ranging from zero to 25 in. Provisions are also included for the use of bituminous surface treatment on some of the

Experiment Design — Flexible Pavement

Loop (16-38)	Traffic	Surface Thickness / Base Thickness / Subbase Thickness	0" (Surface treatment)				1" (AC)				2" (AC)				3" (AC)					4" (AC)					5" (AC)				6" (AC)				Sections	
Loop	Traffic		0	3	6	9	0	3	6	9	0	3	6	9	0	3	6	9	Variable	0	3	6	9	Variable	0	3	6	9	0	3	6	9	per Lane	Test Footage
F	No traffic	0					1		7						(3)G		(9)G								5		11							
		4																																
		8					9		15						(11)(G)		(17)G								13		19							
		12																																
		16					(17)		23						19 G		25(G)								21		(27)						32	1600
	Traffic for conditioning, deflection & strain	0					1		7						(3)G		(9)G								5		11							
		4																																
		8					9		15						(11)(G)		(17)G								13		19							
		12																																
		16					(17)		23						19 G		25(G)								21		(27)						32	1600
E	2 kip single	0	(0)	(3)	(6)		1	4	7		2	(5)	(8)		3	6	9																	
		4	(4)	(7)	[10]		5	8	11		6	[9]	[12]		7	10	13																	
		8																																
		12																																
		16																															34	3400
	6 kip single	0	(0)	(3)	(6)		1	4	7		2	(5)	(8)		3	6	9																	
		4	(4)	(7)	[10]		5	8	11		6	[9]	[12]		7	10	13																	
		8																																
		12																																
		16																															34	3400
A	12 kip single	0									2	5(V)	8		3	6	9		(SW) (GW) (BW)	4	7(V)	(10)												
		4									6	9	12		7	(10)	13			8	11	14												
		8									(10)	13(V)	16		11	14	17			12	15	18												
		12																																
		16																															42	4920
	24 kip tandem	0									2	5(V)	8		3	6	9		(SW) (GW) (BW)	4	7(V)	(10)												
		4									6	9	12		7	(10)	13			8	11	14												
		8									(10)	13(V)	16		11	14	17			12	15	18												
		12																																
		16																															42	4920
B	18 kip single	0																																
		4													7(V)	10	13(V)		(SW) (GW) (CW)	8	11	14			9(V)	12	(15)							
		8													11	14	17			12	(15)	18			13	16	19							
		12													(15)	18	21			16	19	22			17	20	23							
		16																															42	4920
	32 kip tandem	0																																
		4													7(V)	10	13(V)		(SW) (GW) (CW)	8	11	14			9(V)	12	(15)							
		8													11	14	17			12	(15)	18			13	16	19							
		12													(15)	18	21			16	19	22			17	20	23							
		16																															42	4920
C	22.4 kip single	0																																
		4														10(V)	13	16(V)	(GW) (BW) (CW)		11	14	17			12(V)	15	(18)						
		8														14	17	20			15	(18)	21			16	19	22						
		12														(18)	21	24			19	22	25			20	23	26						
		16																															42	4920
	40 kip tandem	0																																
		4														10(V)	13	16(V)	(GW) (BW) (CW)		11	14	17			12(V)	15	(18)						
		8														14	17	20			15	(18)	21			16	19	22						
		12														(18)	21	24			19	22	25			20	23	26						
		16																															42	4920
D	30 kip single	0																																
		4																						(BW) (CW)										
		8																			15(V)	18	21	(SW)		16	19	22		17(V)	20	(23)		
		12																			19	22	25			20	(23)	26		21	24	27		
		16																			(23)(V)	26	29			24	27	30		25	28	31	42	4920
	48 kip tandem	0																																
		4																						(BW) (CW)										
		8																			15(V)	18	21	(SW)		16	19	22		17(V)	20	(23)		
		12																			19	22	25			20	(23)	26		21	24	27		
		16																			(23)(V)	26	29			24	27	30		25	28	31	42	4920
																																Totals	468	49,360

Legend:

- 5 = One section in main factorial, total thickness (5")
- (5) = Replicate factorial section in tangent layout, total thickness (5")
- [5] = Replicate factorial section in acceleration lane, total thickness (5")
- G = Subsurface study section
- (G) = Replicate subsurface study section
- (V) = Two step sections with AC paved shoulder varying from 0' to 8'
- (SW) = Two crushed stone base wedge section. Base from 2" to 14" in Loop A, 2" to 16" in Loop B, 3" to 19" in Loop D.
- (GW) = Two gravel base wedge sections. Base from 2" to 14" in Loop A, 2" to 16" in Loop B, 3" to 18" in Loop C.
- (BW) = Two bituminous stabilized base wedge section. Base from 2" to 11" in Loop A, 3" to 16" in Loop C, 3" to 18" in Loop D.
- (CW) = Two cement stabilized based wedge sections. Base from 2" to 10" in Loop B, 3" to 12" in Loop C, 3" to 13" in Loop D.

Section Length:

Factorial section. 25' in Loop F
100' in Loop A, B, C, D, E
Subsurface study section: 125"
Variable shoulder width and wedge section: 160'

Transitions Lengths:

Between construction blocks, from 60' to 95'
Within blocks, between sections: 7' in Loop F
15' to 60' in Loop A, B, C, D, E

AASHO TEST ROAD July 31, 1956, Revised Sept. 27, 1956., Nov. 6, 1956

TABLE III. Descriptive data for 468 sections of flexible pavement.

sections to be subjected to the lighter axle loads. There are 468 sections of flexible pavement included in this phase of the study. They are described in Table III.

The design of the experiment follows the most modern scientific, statistical experimental design techniques in order that a maximum of effective information may be obtained from a minimum number of test sections. A panel of eminent mathematical statisticians has been appointed to guide the Highway Research Board and staff in the experimental design. Engineers and other qualified technical people are being procured from all parts of the country.

Since early spring all activities have moved at a very rapid pace. Our staffing requirements were tremendous. It was necessary to secure a number of engineers and other professional personnel with specific talents and experience. Sufficient time to train a staff was not available. In April the entire staff, including the Illinois task force, numbered 16. We now have a staff of 125 people, most of them busily engaged in construction control and testing for the grading contract. The State of Illinois through its task force has furnished 14 engineers. The BPR has furnished 12. We were fortunate in obtaining the services of six experienced engineers on a loan basis—one each from the states of Ohio, Wisconsin, Iowa, Missouri, Kansas, and Oklahoma. The remainder of the staff of engineers, other technical people, technicians, and

Loop	Traffic	Slab Thickness	2.5 R	2.5 N	3.5 R	3.5 N	5.0 R	5.0 N	6.5 R	6.5 N	8.0 R	8.0 N	9.5 R	9.5 N	11.0 R	11.0 N	12.5 R	12.5 N	Sections per Lane	Test Footage
F	No traffic	0	⊗	x			x	⊗⊙					⊗	x			x	⊗		
		3																		
		6	⊗	x			x	⊗⊙					⊗	x			x	⊗		
		9																	28	1140
	Traffic for conditioning, deflections & strains	0	⊗	x			x	⊗⊙					⊗	x			x	⊗		
		3																		
		6	⊗	x			x	⊗⊙					⊗	x			x	⊗		
		9																	28	1140
E	2 kip single	0	x	x	x	x	x	x												
		3	x	x	x	x	x	x												
		6	x	x	x	x	x	x												
		9																	20	3600
	6 kip single	0	x	x	x	x	x	x												
		3	x	x	x	x	x	x												
		6																		
		9																	20	3600
A	12 kip single	0			5S				5S											
		3	x	x	⊗	x	x	⊗	x	x										
		6	x	xS	x	⊗	⊗	xS	x	x										
		9	x	x	x	x	x	x	x	x									34	5760
	24 kip tandem	0			5S				5S											
		3	x	x	⊗	x	x	⊗	x	x										
		6	x	xS	x	⊗	⊗	xS	x	x										
		9	x	x	x	x	x	x	x	x									34	5760
B	18 kip single	0				5S				5S										
		3				x	x	⊗	x	x	⊗	x	x							
		6				x	xS	x	⊗	⊗	xS	x	x							
		9				x	x	x	x	x	x	x	x						34	5760
	32 kip tandem	0				5S				5S										
		3				x	x	⊗	x	x	⊗	x	x							
		6				x	xS	x	⊗	⊗	xS	x	x							
		9				x	x	x	x	x	x	x	x						34	5760
C	22.4 kip single	0						5S				5S								
		3					x	x	⊗	x	x	⊗	x	x						
		6					x	xS	x	⊗	⊗	xS	x	x						
		9					x	x	x	x	x	x	x	x					34	5760
	40 kip tandem	0						5S				5S								
		3					x	x	⊗	x	x	⊗	x	x						
		6					x	xS	x	⊗	⊗	xS	x	x						
		9					x	x	x	x	x	x	x	x					34	5760
D	30 kip single	0								5S				5S						
		3							x	x	⊗	x	x	⊗	x	x				
		6							x	xS	x	⊗	⊗	xS	x	x				
		9							x	x	x	x	x	x	x	x			34	5760
	48 kip tandem	0								5S				5S						
		3							x	x	⊗	x	x	⊗	x	x				
		6							x	xS	x	⊗	⊗	xS	x	x				
		9							x	x	x	x	x	x	x	x			34	5760
																		Totals	368	55,560

four main test loops each consist of 6,600-ft test sections of divided roadway connected at each end by a turn-around of 200-ft radius. The total distance around each loop is 3.1 miles.

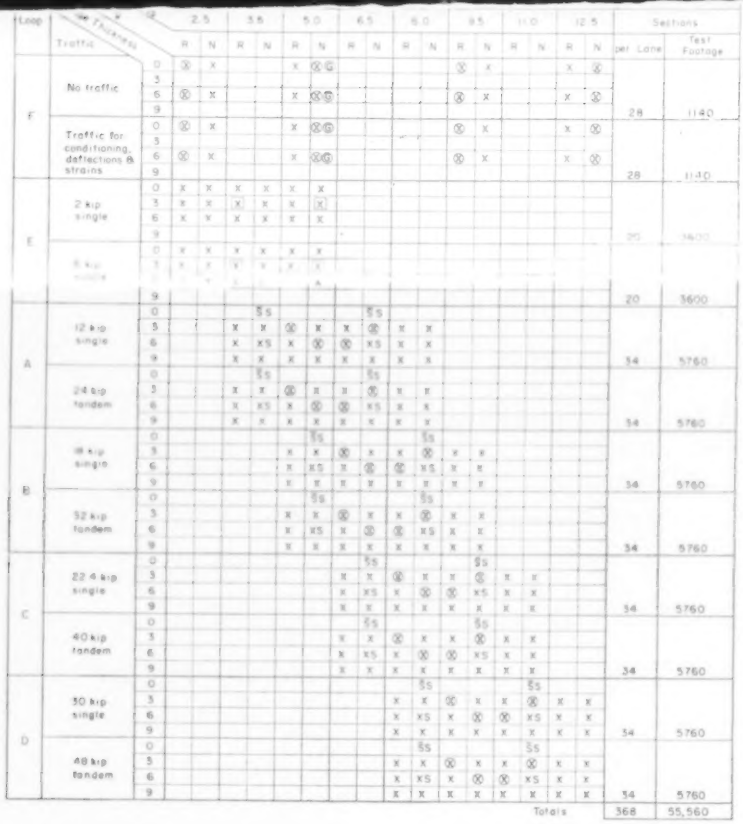
The newly enacted Federal Highway Bill (1956) recognizes the AASHO Road Test and requires an interim report to Congress on it in March 1959. To comply with some of the Congressional requests for additional information, a fifth loop was added for light vehicles. This loop is approximately 5,000 ft in length and is located adjacent to one of the main loops on land acquired in connection with the main right-of-way. For special studies there is another auxiliary loop approximately 2,200 ft long, located nearby.

Half of the test pavements will be of rigid type (non-reinforced and reinforced concrete) and the other half will be of flexible type (asphaltic concrete). The project also includes 16 test bridges—eight of steel-girder construction, four of conventional concrete, and four of prestressed concrete. These will be built in the loops carrying the four heaviest axle loads, as indicated in Fig. 4. See also Table IV.

Truck-tractor semi-trailers and smaller two-axle vehicles will be used as the test vehicles. These vehicles will be loaded to provide, on the single-axle types, loads of 2,000, 6,000, 12,000, 18,000, 22,400 and 30,000 lb, and on the tandem axle types, loads of 24,000

Asphalt Institute Design of Flexible Pavements

Loop	Traffic	Structure Thickness	0" (Surface treatment) 0 3 6 9	1" (AC) 0 3 6 9	2" (AC) 0 3 6 9	3" (AC) 0 3 6 9 Variable	4" (AC) 0 3 6 9 Variable	5" (AC) 0 3 6 9	6" (AC) 0 3 6 9	Sections per Lane	Sections Test Footage
F	No traffic	0		1 7		3 G 9 G		5 11			
		4									
		8		9 15		(11) G (17) G		13 19			
		12									
		16		(17) 23		19 G 25 G		21 (27)		32	1600
	Traffic for conditioning, deflection & strain	0		1 7		3 G 9 G		5 11			
		4									
		8		9 15		(11) G (17) G		13 19			
		12									
		16		(17) 23		19 G 25 G		21 (27)		32	1600
	2 kip single	0	0 3 6	1 4 7	2 5 8	5 6 9					
		4	4 7 10	5 8 11	6 9 12	7 10 13					
		8									
		12									
		16									54
	6 kip single	4	4 7 10	5 8 11	6 9 12	7 10 13					
		8									
		12									
		16								54	5400
A	12 kip single	0			2 5 (7) 8	5 6 9	SW SW SW	4 7 (9)			
		4			6 9 12	7 (10) 13		8 11 14			
		8			(13) 15 (7) 16	11 14 17		12 15 18			
		12									
		16								42	4920
	24 kip tandem	0			2 5 (7) 8	5 6 9	SW SW SW	4 7 (9)			
		4			6 9 12	7 (10) 13		8 11 14			
		8			(13) 15 (7) 16	11 14 17		12 15 18			
		12									
		16								42	4920
B	18 kip single	0				7 (9) 10 (12)	SW SW SW	8 11 14	9 (12) 15		
		4				11 14 17		12 (15) 18	13 16 19		
		8				(15) 18 21		16 19 22	17 20 23		
		12									
		16								42	4920
	32 kip tandem	0				7 (9) 10 (12)	SW SW SW	8 11 14	9 (12) 15		
		4				11 14 17		12 (15) 18	13 16 19		
		8				(15) 18 21		16 19 22	17 20 23		
		12									
		16								42	4920
C	22.4 kip single	0				10 (12) 13 16 (18) SW SW SW		11 14 17	12 (15) 18		
		4				14 17 20		15 (18) 21	16 19 22		
		8				(18) 21 24		19 22 25	20 23 26		
		12									
		16								42	4920
	40 kip tandem	0				10 (12) 13 16 (18) SW SW SW		11 14 17	12 (15) 18		
		4				14 17 20		15 (18) 21	16 19 22		
		8				(18) 21 24		19 22 25	20 23 26		
		12									
		16								42	4920
D	30 kip single	0					SW SW				
		4									
		8					(SW)	15 (18) 21	16 19 22	17 (20) (23)	
		12						19 22 25	20 23 26	21 24 27	
		16									



Loop	Traffic	Slab Thickness	2.5 R	2.5 N	3.5 R	3.5 N	5.0 R	5.0 N	6.5 R	6.5 N	8.0 R	8.0 N	9.5 R	9.5 N	11.0 R	11.0 N	12.5 R	12.5 N	Sections per Lane	Test Footage
F	No traffic	0	⊗	x			x	⊗G					⊗	x			x	⊗		
		3																		
		6	⊗	x			x	⊗⊗					⊗	x			x	⊗		
		9																	28	1140
	Traffic for conditioning, deflections & strains	0	⊗	x			x	⊗⊗					⊗	x			x	⊗		
		3																		
		6	⊗	x			x	⊗⊗					⊗	x			x	⊗		
		9																	28	1140
E	2 kip single	0	x	x	x	x	x	x												
		3	x	x	x	x	x	x												
		6	x	x	x	x	x	x												
		9																	20	800
	8 kip single	0	x	x	x	x	x	x												
		3	x	x	x	x	x	x												
		6	x	x	x	x	x	x												
		9																	20	800
A	12 kip single	0			S	S					S	S								
		5			x	x	⊗	x	x	⊗	x	x								
		6			x	xS	x	⊗	⊗	xS	x	x								
		9			x	x	x	x	x	x	x	x							34	5760
	24 kip tandem	0			S	S				S										
		5			x	x	⊗	x	x	⊗	x	x								
		6			x	xS	x	⊗	⊗	xS	x	x								
		9			x	x	x	x	x	x	x	x							34	5760
B	18 kip single	0					S	S			S	S								
		5					x	x	⊗	x	x	⊗	x	x						
		6					x	xS	x	⊗	⊗	xS	x	x						
		9					x	x	x	x	x	x	x	x					34	5760
	32 kip tandem	0					S	S			S	S								
		5					x	x	⊗	x	x	⊗	x	x						
		6					x	xS	x	⊗	⊗	xS	x	x						
		9					x	x	x	x	x	x	x	x					34	5760
C	22.4 kip single	0							S	S			S	S						
		5							x	x	⊗	x	x	⊗	x	x				
		6							x	xS	x	⊗	⊗	xS	x	x				
		9							x	x	x	x	x	x	x	x			34	5760
	40 kip tandem	0							S	S			S	S						
		5							x	x	⊗	x	x	⊗	x	x				
		6							x	xS	x	⊗	⊗	xS	x	x				
		9							x	x	x	x	x	x	x	x			34	5760
D	30 kip single	0									S	S			S	S				
		5									x	x	⊗	x	x	⊗	x	x		
		6									x	xS	x	⊗	⊗	xS	x	x		
		9									x	x	x	x	x	x	x	x	34	5760
	48 kip tandem	0									S	S			S	S				
		5									x	x	⊗	x	x	⊗	x	x		
		6									x	xS	x	⊗	⊗	xS	x	x		
		9									x	x	x	x	x	x	x	x	34	5760
																		Totals	368	55,560

Legend

- X = One section in main factorial
- ⊗ = Replicate factorial section in tangent layout
- ⊠ = Replicate factorial section in acceleration lane
- S = Special study section – no paved shoulder
- S = Special study section – 6' AC shoulder
- G = Two sections for subsurface study

July 31, 1956, revised Sept. 27, 1956

Section Length

Reinforced section: 240' in Loop A, B, C, D, E
40' in Loop F

Non-reinforced section: 120' in Loop A, B, C, D, E
15' in Loop F

Subsurface study section in Loop F: 120'

Transitions Length

Between construction blocks: 60' to 90'
Within blocks, between sections: 10' to 40'

TABLE II. Descriptive data for 368 sections of rigid pavement

Organization at test site

Beginning in the early summer of 1955, the Highway Research Board started to organize for the gigantic task ahead. First on the scene was W. N. Carey, Jr., A.M. ASCE, Chief Engineer for Research. This was in August 1955. The staff grew slowly, working on the plans for quarters for the staff group, the experimental design, and many other aspects of the project. In April 1956, Project Director W. B. McKendrick, Jr., M. ASCE, former chief engineer of the State Highway Department of Delaware, was appointed.

The organization for the project, which appears in Fig. 1, is on a functional basis. There are 11 branches, each headed by a branch supervisor: public relations, instrumentation, vehicle operations, construction, maintenance, materials laboratory, special assignments, bridge research, flexible pavement research, rigid pavement research, and data processing and analysis. The Highway Research Board has secured well qualified people to fill these top posts.

Both flexible and rigid pavement tests

The test is to be made on a four-lane divided highway which is to become a part of an eight-mile relocation of U.S. 6 near Ottawa, Ill., after the test is completed. The geographical location of the project and the layout of the test four main test loops each consist of 6,600-ft test sections of divided roadway connected at each end by a turn-around of 200-ft radius. The total distance around each loop is 3.1 miles.

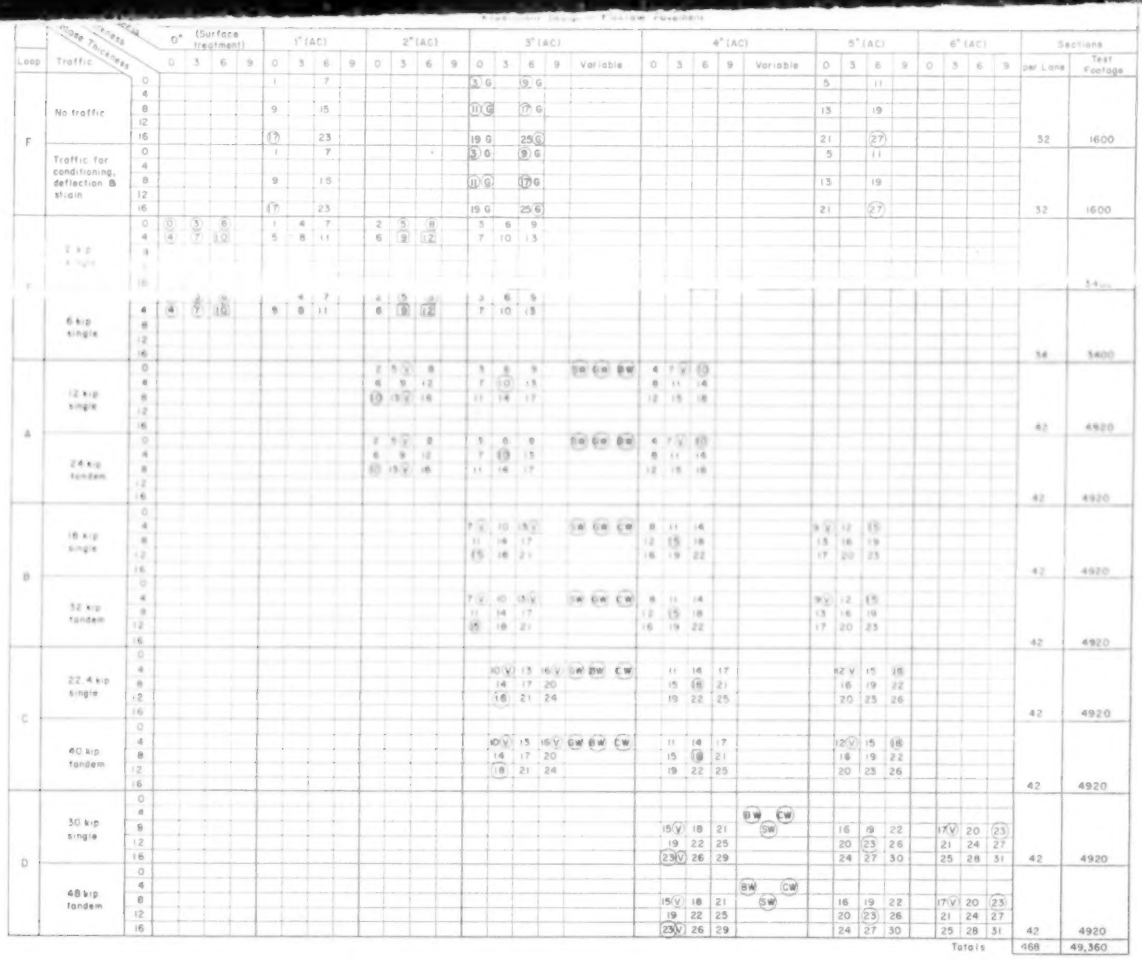
The newly enacted Federal Highway Bill (1956) recognizes the AASHO Road Test and requires an interim report to Congress on it in March 1959. To comply with some of the Congressional requests for additional information, a fifth loop was added for light vehicles. This loop is approximately 5,000 ft in length and is located adjacent to one of the main loops on land acquired in connection with the main right-of-way. For special studies there is another auxiliary loop approximately 2,200 ft long, located nearby.

Half of the test pavements will be of rigid type (non-reinforced and reinforced concrete) and the other half will be of flexible type (asphaltic concrete). The project also includes 16 test bridges—eight of steel-girder construction, four of conventional concrete, and four of prestressed concrete. These will be built in the loops carrying the four heaviest axle loads, as indicated in Fig. 4. See also Table IV.

Truck-tractor semi-trailers and smaller two-axle vehicles will be used as the test vehicles. These vehicles will be loaded to provide, on the single-axle types, loads of 2,000, 6,000, 12,000, 18,000, 22,400 and 30,000 lb, and on the tandem axle types, loads of 24,000, 32,000, 40,000, and 48,000 lb. Loads will be applied for a period of two years. More than a million axle loads will be applied on each test section. The vehicles will be driven at approximately 30 mph, around the loops in the direction of normal traffic, applying the single axles on the inside lanes and the tandem axles on the outside lanes. They will operate 18 hours a day and 6 days a week. Each loop will have two test lanes with concrete pavement on one side of the dividing strip and bituminous pavement on the other side.

The portland-cement-concrete slabs will be varied from $2\frac{1}{2}$ to $12\frac{1}{2}$ in. in thickness. Some of these slabs will be placed directly on the soil, but the large majority will be laid on a granular subbase varying in thickness from 3 to 9 in. Both plain and reinforced concrete will be used. The experimental design, as now set up, includes 368 sections of rigid pavement, described in Table II.

The asphaltic concrete surfacing of the flexible pavements will vary in thickness from 1 to 6 in., and these surfaces are to be laid on various combinations of base and subbase thicknesses ranging from zero to 25 in. Provisions are also included for the use of bituminous surface treatment on some of the



Legend

5 = One section in main factorial, total thickness (5")
(5) = Replicate factorial section in tangent layout, total thickness (5")
[5] = Replicate factorial section in acceleration lane, total thickness (5")
G = Subsurface study section
(G) = Replicate subsurface study section
(V) = Two step sections with AC paved shoulder varying from 0' to 8'
(SW) = Two crushed stone base wedge section. Base from 2" to 14" in Loop A, 2" to 16" in Loop B, 3" to 19" in Loop D.
(GW) = Two gravel base wedge sections. Base from 2" to 14" in Loop A, 2" to 16" in Loop B, 3" to 18" in Loop C.
(BW) = Two bituminous stabilized base wedge section. Base from 2" to 11" in Loop A, 3" to 16" in Loop C, 3" to 18" in Loop D.
(CW) = Two cement stabilized based wedge sections. Base from 2" to 10" in Loop B, 3" to 12" in Loop C, 3" to 13" in Loop D.

Section Length:

Factorial section: 25' in Loop F
100' in Loop A, B, C, D, E
Subsurface study section: 125"
Variable shoulder width and wedge section: 160'

Transitions Lengths:

Between construction blocks, from 60' to 95'
Within blocks, between sections: 7' in Loop F
15' to 60' in Loop A, B, C, D, E

AASHO TEST ROAD July 31, 1956, Revised Sept. 27, 1956., Nov. 6, 1956

TABLE III. Descriptive data for 468 sections of flexible pavement.

sections to be subjected to the lighter axle loads. There are 468 sections of flexible pavement included in this phase of the study. They are described in Table III.

The design of the experiment follows the most modern scientific, statistical experimental design techniques in order that a maximum of effective information may be obtained from a minimum number of test sections. A panel of eminent mathematical statisticians has been appointed to guide the Highway Research Board and staff in the experimental design. Engineers and other qualified technical people are being procured from all parts of the country.

Since early spring all activities have moved at a very rapid pace. Our staffing requirements were tremendous. It was necessary to secure a number of engineers and other professional personnel with specific talents and experience. Sufficient time to train a staff was not available. In April the entire staff, including the Illinois task force, numbered 16. We now have a staff of 125 people, most of them busily engaged in construction control and testing for the grading contract. The State of Illinois through its task force has furnished 14 engineers. The BPR has furnished 12. We were fortunate in obtaining the services of six experienced engineers on a loan basis—one each from the states of Ohio, Wisconsin, Iowa, Missouri, Kansas, and Oklahoma. The remainder of the staff of engineers, other technical people, technicians, and

Field density sample is being taken on compacted 4-in. lift with tube density sampler.

Type of Span		Steel Spans								Concrete Spans					
										Prestressed				Conven.	
Design Stress Level (psi)		27,000				35,000				300		800		30,000	40,000
Structural Character-istics / Loop / Lane		Non-Composite		Composite		Non-Composite		Composite							
		No BCP	BCP	No BCP	BCP	No BCP	BCP	No BCP	BCP	Pre-tens.	Post-tens.	Pre-tens.	Post-tens.		
C	22.4 Kip Single		1A			1B				6B		6A			
	40 Kip Tandem					2A			2B		5B		5A		
D	30 Kip Single	3A			3B									8A 8B	
	48 Kip Tandem						4A 4B								7A 7B

Note: BCP = Bottom cover plates.

TABLE IV. Experimental design for bridges in AASHO Road Test

engineering aids have been employed by the Highway Research Board. The technical personnel have come from far and wide; the non-technical people have been hired locally.

Plans were completed and bids were received in June 1956 for an office and laboratory building of 11,400 sq ft. This building is located adjacent to the right-of-way and approximately at the center of the construction project. Work was started in late July, and we expect to move into the building on December 1.

In the meantime it was necessary to establish a temporary laboratory to handle the great volume of testing work for the grading contract. A prefabricated steel building 16 × 32 ft was erected adjacent to the site of the office and laboratory building. We enlarged the available space by pouring a concrete slab adjacent to this building and erecting a canvas tent over it. While these quarters have been very cramped, they have served satisfactorily. The number of tests flowing daily through the laboratory is approximately 800.

Construction at site

Construction work is divided into six separate contracts: (1) grading, (2) small bridges, (3) structural steel for the superstructure of the test bridges and four overhead bridges, (4) substructure for the overhead bridges and test bridges, (5) superstructure for the four overheads and the test bridges, and (6) paving. Number one, the grading contract, is of prime concern at this time. Plans were completed for this work in early June and bids were received in early July. The low bid was a combination bid received from S. J. Groves and Company and Midwest Arcole. Both are midwestern contractors. Their bid included all of the grading work—1,500,000 cu yd—and the substructures for the overhead bridges. The total price was $2,025,000.

The grading project was planned so that the contractors' equipment would work on all five loops simultaneously. Work started in early August and will be completed by November 15 if favorable weather conditions prevail.

The 3-ft soil embankment is being built in 4-in. compacted lifts using conventional equipment, with close controls on the resulting densities. Each lift must have a density between 95 and 100 Standard Proctor before another lift can be placed. This result is being obtained by close control of the amount of water added to each of the rotary speed mixers as three of them operate in tandem over the 6-in. loose layer of soil on the grade. The grading construction in each loop is carried out in blocks of 500 to 800 ft in length. The areas at the end of these blocks, used for turnarounds for the grading equipment, will not be included in the final analyses of the data.

The contractors have over 200 pieces of equipment of various types on the project. As an example, in each loop there are four to ten earth movers, five rotary speed mixers, three rubber-tired rollers, three water trucks, and numerous other equipment such as shovels and maintenance vehicles. Production depends on a highly coordinated rhythmic movement of all men and equipment in each loop. A two-way radio system has been installed to permit rapid communication between the engineer in charge of grading on any of the loops and the central laboratory, to obtain the results of moisture control tests; also between the field crews making the density tests and the central laboratory. With the construction activities stretched out over several miles, this method of rapid communication is contributing much to minimize delays in equipment operation. At present the contractors are moving 20,000 to 25,000 cu yd of earth a day.

Target dates set

A number of major target dates have been established in order to provide a schedule for the project. This is a tremendously ambitious program requiring a high degree of coordination and correlation of all its aspects. As now conceived, the vehicle test traffic will start in the early fall of 1957. Traffic will run continually until late 1959 or early 1960, and about one year will be required for the preparation of reports.

(This article is based on the paper by the authors which was presented at the ASCE Pittsburgh Convention, before the Highway Division session presided over by J. W. McKnight, a member of the Division's Program Committee.)

AASHO Road Test office and laboratory building nears completion. Structure, located approximately at center of construction project, contains 11,400 sq ft.

Civil engineers can write—history says so

WALTER JAMES MILLER, Assistant Professor of English, Polytechnic Institute of Brooklyn, Brooklyn, New York

Societies, schools, and journals have been campaigning for a decade now to improve the writing of the engineer. Obviously the campaign is making the engineer "writing conscious." Everybody now admits that reports should be readable and papers hearable. But it's time to admit also that the emphasis has been cockeyed and the perspective myopic.

The idea has been, "Now that these inarticulate slide-rule fiends are approaching professional status and historical importance, it's time to teach them the alphabet."

The correct emphasis is, "Now that engineers are staggering under new loads of specialized knowledge, we must make certain they don't lose sight of one of their finest traditions—the tradition of excellent writing maintained by leading engineers for two thousand years."

Unfortunately many engineers and educators *have* lost sight of this tradition. This, it seems to me, is one reason for the poor quality that characterizes much of today's engineering writing, for good writing is a craft passed on from generation to generation. The biologist writes in the tradition of Darwin, whom he reads. The philosopher compares himself with Plato, whom he reads. The historian knows historians can write because he reads Prescott. The physician is inspired by Hippocrates.

But ask a recent engineering graduate (or his professor) if he has actually *read* Frontinus, Telford, Rankine. Probably, he hasn't even read Wellington. If we want engineers to write well, we must acquaint them with the classics of their own professional literature.

The classics show that in twenty centuries engineers have developed the report and the treatise into powerful, flexible instruments of expression. The major engineering writers have relied on their engineer's aptitude for design, but they have also demonstrated their skill with metaphor and rhetorical devices, and often they have achieved the mark of the real writer—style. Many classics are charged with civic, even social consciousness; a few are landmarks in the history of ideas. Engineering writers have attained such literary competence that often they have ventured successfully into the field of general literature, such as autobiography, history, poetry.

Big names in engineering literature

To illustrate these points, I need only mention some of the big names in engineering literature. Here I will mention only civil engineers.

Marcus Vitruvius Pollio in his *Architecture* (27 B.C.), sums up ancient knowledge in what we call civil, mechanical, and military engineering *and* architecture. This work is distinguished for its noble conception of the master builder, its simplicity of style, homely metaphors, neat examples, attention to the reader's needs.

Sextus Julius Frontinus, in his *Aqueducts of Rome* (97 A.D.), earliest full-length engineering report extant, interests us for his portrayal of the engineer in action, his sly humor, metaphor, epigram, his admission that readers differ in their technical interests.

John Smeaton's *Narrative of the Building of the Eddystone Lighthouse* (1793) is a warm, often poetic account of the writer's design of the now classic structure and his struggles to root it on a dangerous reef. In his reports and papers, published posthumously (1812–1814) by admirers, Smeaton handles technical subjects in layman's English.

John Loudon McAdam's report to Britain's Board of Agriculture, printed in his *Remarks on the Present System of Road-Making* (1820), is remarkable for the way it explains the subject to laymen, for its crisp language, choice diction, superb but simple metaphor. McAdam's writings helped make England engineering conscious. For a time "to macadamize" actually meant "to do in a scientific way."

Thomas Telford in his *Life* (1838) includes accounts of his major projects, a selection of his best professional reports, and his best poem, "Eskdale." His poem to Robert Burns was published in Currie's *Life and Work of Burns;* his poetry was praised by the Poet Laureate, Robert Southey.

William J. M. Rankine wrote manuals (1858–1869) which treat of engineering on the highest philosophical and scholarly level, and mark a turning point in engineering history as it evolved from an empirical pursuit into a science. Rankine is known to philosophers for distinguishing the "two modes of progress"—not as the practical and the theoretical, but as the empirical and the scientific.

Arthur M. Wellington is the author of the first great engineering treatise written on this side of the Atlantic. This treatise, the *Economic Theory of the Location of Railways* (1887) is famous for its vigorous language, rhetorical boldness, and memorable statements—some of them now proverbs of the profession.

More recent examples cited

Othmar H. Ammann's reports are perfect examples of the modern "double report" form. His *Tentative Report on the Hudson River Bridge* (1926) is characterized by graceful language, economy of expression, functional organization.

William Barclay Parsons, a prolific writer, left for posthumous publication his masterpiece, *Engineers and Engineering in the Renaissance* (1939). This book was hailed by Nicholas Murray Butler as "a classic of the literature of the history of engineering."

James K. Finch's *Engineering and Western Civilization* (1951) is the best general history of the profession. It is noteworthy for its contribution to the philosophy of history and its succinct summary of fifty centuries.

David B. Steinman may come to be known as the Telford of American engineering literature. In addition to his hundreds of papers and monographs for engineers, he has written for laymen three books on bridges, including one for children, and has collected his verse into the volume, *I Built a Bridge and Other Poems* (1955). In his poetry Steinman reveals his awareness of the psychological symbolism of the bridge. In all his writings, he consciously tests the power of language.

Direct acquaintance with writings like these should convince the engineer that, so far as literary ability is concerned, his profession has nothing to apologize for, and that personally he has a lot to live up to.

Cables support cantilevered hangar roof

DONALD R. PEIRCE, Associate, Ammann & Whitney, New York, N. Y.

Still another answer has been given to the ever-present problem of providing the largest possible unobstructed floor area to house today's bigger and bigger aircraft. This answer is incorporated in the maintenance hangar now under construction at the Philadelphia International Airport by the City of Philadelphia for Trans World Airlines. It will permit the airline to more than double its maintenance operations at the airport.

The design is unique in that it combines an arched and cantilevered steel roof section with a supporting concrete bent, the end of the cantilever being supported by high tensile cables anchored to the bent. Including hangar and overhang, the ground floor covers 53,000 sq ft. There is also a 2,600-sq ft mezzanine and a 12,200-sq ft second floor area providing lounges, dormitories, and other facilities for flight and maintenance crews. The hangar will be able to house and service two Super-G Constellations at one time.

As designed, it provides a column-free hangar bay 135 ft deep by 270 ft long. Future plans call for doubling its length to 540 ft.

Advantages of the cantilever

It is sometimes thought that cantilever construction is costly and that it should be avoided when possible. In many cases this is true. However, there are many advantages to the cantilever, advantages which were exploited by the type of framing selected by the Ballinger Company, architects and engineers, and Ammann & Whitney, consulting engineers.

A hangar is necessarily a long-span structure, and a considerable premium is placed on simplicity and ease of construction. Several types of economical cantilever framing have been developed in both steel and reinforced concrete. Economically they all depend on simple structural elements and erection procedures, with a high degree of repetition. The cantilever is in itself an elementary structural form, readily adaptable to simplification.

Also in the cantilever type, all loads are concentrated in a small number of heavy columns and footings which usually will reduce footing costs, as compared to a larger number of lightly loaded columns.

It should be recognized, in addition, that even in the main frame there are a number of elements which remain virtually unchanged regardless of the particular method of accomplishing the long span. These include lateral bracing members for wind loads, roof deck and purlins or other subframing, and related elements whose behavior is unaffected by the length of the span.

Partially as a result of these factors and partially because of the attention recently given to the cantilever hangar as a type, the costs of cantilever hangars have been reduced, in most cases to the point where they are competitive with other less flexible types.

In most long-span roof structures, the span lengths plus the relatively light, uniformly distributed loads result in high static moments, but with the shears relatively low as compared to the moments. If a catenary is employed to carry the load, either in tension as in a suspension bridge, or in compression as in an arch, the moments in the structural elements themselves are largely eliminated by shaping the catenary to follow the static moment curves, and the major part of the shear becomes a component of the axial load.

While a catenary can be used to balance the forces (shears and moments) produced in a cantilever structure, it has not been customary to utilize it. More conventional structural forms, on the other hand, have serious drawbacks.

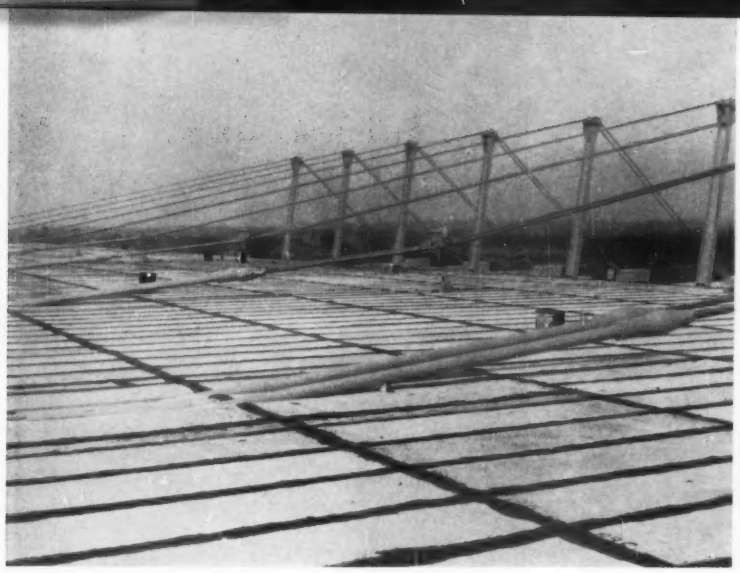
Beams with solid webs are in general uneconomical for long cantilevers because the nature of the forces demands great depth and heavy flanges to handle the moments, while the web can be quite light and still be adequate for the shear. A rectangular section is obviously not suitable. An I-beam of wood, concrete, or steel is a better section, but still the web is too heavy and too costly.

With a truss, it will generally be found that the depth desirable for economy in the chords will lead to excess material in the web members because of their length.

It has been economical for long cantilevers (in excess of 110 ft approximately) to eliminate the web system, either partially or completely, and to carry part or all of the shear directly in the chords. This will of course result in relatively high local moments in one or the other of the chords, and this chord in many cases is actually a relatively shallow truss, the other chord being a tension tie-back over a strut at the root of the cantilever. Such "suspended trusses" have been used by Ammann & Whitney in an Air Force hangar at Chateauroux, by the Port of New York Authority at Idlewild, and by others elsewhere.

The system finally evolved for the Philadelphia hangar consists of a cable suspender and 36WF ribs 30 ft on centers. Continuous purlins span between the ribs, and on these purlins the roof deck is placed. The suspenders are two $2^{9}/_{16}$-in. bridge strands which pass over a relatively light mast 32 ft high. The ten pairs of strands, each pair with a total load of 392 tons, are then anchored in the heavy concrete bent framing the lean-to. This relatively simple structural system is shown in Fig. 1. The placing of the cables may appear as a long and difficult operation. Actually, two cables can be erected in a day without difficulty.

It is evident that the axial load in the 36WF ribs will be quite high (564 kips, dead load plus full live load), as a result of the horizontal component of the cable tension. This corresponds to the compression in the bottom chord of an elementary cantilever truss. Also,



Roof is decked with precast concrete slabs having specified minimum weight of 13 psf. Minimum weight was fixed to provide optimum balance of dead loads and uplift (wind) loads.

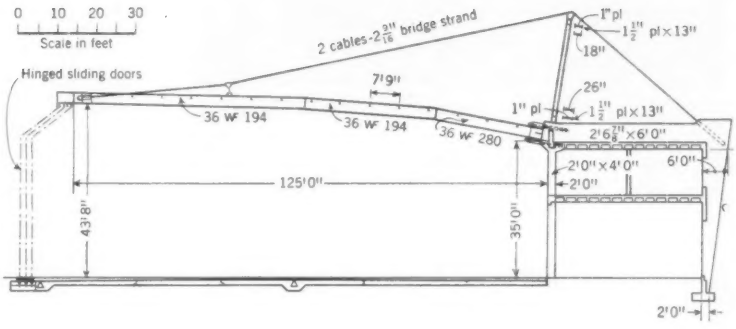
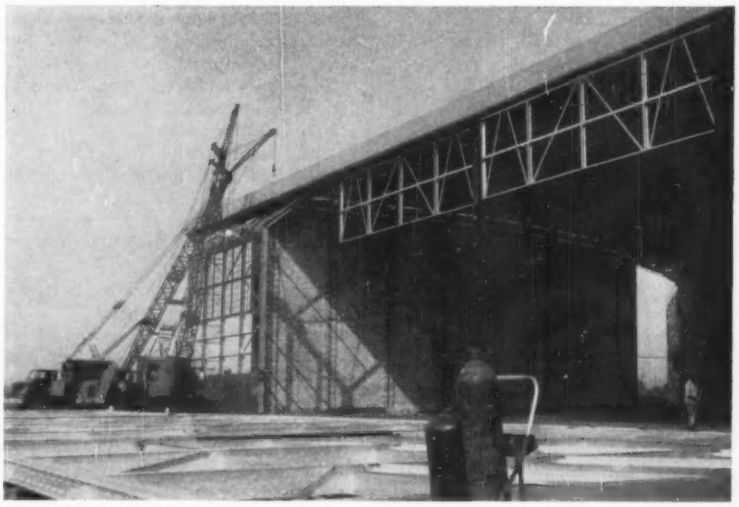


FIG. 1. Cross section through one of hangar's ten bents shows method of supporting end of long roof cantilever by two cables, which pass over steel mast and are anchored to rear of reinforced concrete bent. Rear leg of bent is anchored by tension piles. By this means clear unsupported hangar area 135 ft by 270 ft is obtained.

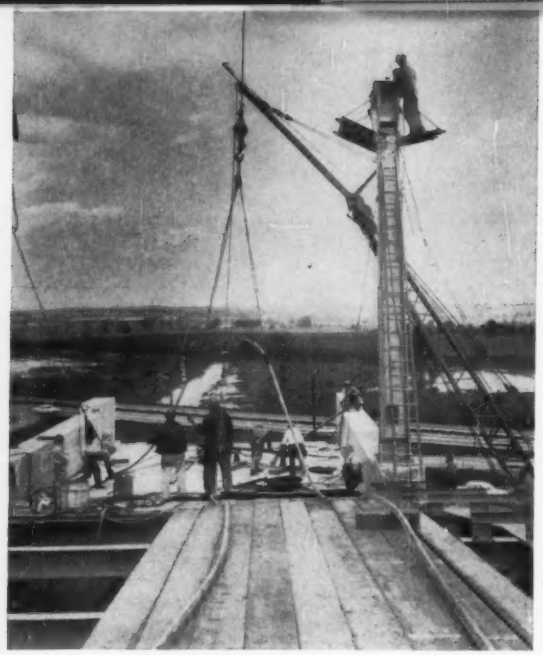
it would be expected that the bending moments in the rib would be quite high. The moments of course vary markedly and somewhat irregularly over the length of the rib because of its shape. The maximum moment for this loading condition occurs at the connection of the rib to the bent, and amounts to 797 kip-ft, but drops off very rapidly. In general, except for this area, the maximum moments are not in excess of 400 kip-ft for any of the loading conditions except the maximum uplift condition. However, neither the axial load nor the bending moments are beyond the capacity of standard 36WF sections reinforced locally with relatively light cover plates.

The shape of the rib reduces the shear in the member because of the vertical component, but this is of incidental importance, since the shears are light, and well within the capacity of the section. Lateral buckling of the rib is effectively restrained by the purlins and lateral bracing, while by curving the rib slightly and controlling the point of application of the axial load, the bending moments



Hangar has six motor-operated steel doors. At top of door is sloping canopy, which is hinged at both top and bottom so as to allow for deflection of cantilevered steel roof ribs.

Steel ribs of new TWA hangar at Philadelphia International Airport cantilever out 125 ft from concrete supporting bent. Tieback cable, shown being unreeled, will pass over steel mast at right.



Two cranes hoist cable into position on saddle atop mast. Spreader bar (not shown) was used to prevent kinking.

can be kept within the capacity of the section. It would be possible of course to set the configuration of the rib and suspenders so that the pressure line of the axial load would follow the axis of the rib more or less exactly. That is to say, the rib could be designed as one-half of an arch, tied back at the crown.

For such a solution the cables would necessarily have to be tangent to the rib at the outer end. This would lead either to a very flat arch with excessive thrust, or else to the use of a very high mast and a rib configuration not corresponding at all well with the required clearances in the hangar, and resulting in excessive enclosed volume and wall area.

As designed, the rib consists of three straight chords, with splices at the break points. One field splice is necessary because of shipping restrictions. It was felt that this solution represented the best possible resolution of the somewhat conflicting structural, esthetic, economic and dimensional requirements.

The final roof outline corresponds very closely to TWA's clearance requirements, and the 36-in. depth of the ribs is not excessive; in fact, it is not enough to house all the mechanical facilities, and the enclosed volume is held close to the irreducible minimum. The roof line itself, the light mast and suspenders, and the massive supporting frame were all felt to be esthetically pleasing.

The ceiling of the hangar is quite clean and uncluttered, a desirable feature for appearance and ease of maintenance. This ceiling also permits the use of direct-indirect fluorescent lighting fixtures which throw part of their light upward, illuminating the entire ceiling, improving the uniformity of lighting intensity, and reducing the contrast or glare attendant on a dark ceiling. Deep trusses would not have allowed this type of lighting.

The total weight of structural steel used in this design is somewhat greater than would be required by a suspended truss design, as might be expected, but the fabrication and erection is simplified, the tonnage being concentrated in fewer members, and the two systems therefore compare favorably in cost.

It is obvious that overturning due to dead load and snow load is a problem with a long cantilever anchored into a narrow lean-to. This problem was dealt with by the use of relatively heavy framing in the lean-to, and the use of tension piles under the rear leg of the bents.

Uplift moments, a difficult problem

Wind-load uplift on the cantilever also presented a difficult design problem. At a wind velocity of approximately 120 mph, the uplift equals the dead load of the cantilever structure. The cables, of course, cannot take compression. Thus, for higher velocities the ribs act as pure cantilevers, a moment connection being provided at the bent. This moment connection is prestressed after erection and alignment of the ribs by tensioning all the anchor bolts equally. Prestress not only reduces rotations under load at the connection, but also assures favorable stress conditions for transmitting shear under all loading conditions.

To control the moments in the rib due to uplift, a balance had to be struck between low dead load, with higher net uplift forces, and a higher dead load but

Cable is high-tensile galvanized bridge wire. Each pair of strands, for one "suspended truss," carry load of 329 tons.

All hands are needed to slide anchor bolt of cable into position through concrete supporting bent. Bolt was attached to cable at erection site.

with low net uplift. This was done by using a precast concrete channel slab for the roof deck, with a specified *minimum* weight of 13 psf.

The precast concrete deck, in addition to supplying the best balance of vertical loads (downward) and wind forces (uplift), is felt to be superior to a lighter metal deck from the standpoint of maintenance costs and durability. The cost compares favorably with other types of decking.

The rib is designed for a wind velocity of 150 mph. While it is extremely unlikely that sustained wind with velocities in excess of this amount will ever be encountered, the uplift forces which might be transmitted to the main frame by higher velocities (or by explosions inside the hangar) are limited by the capacity of the connections of the precast deck. These connections will fail at an uplift corresponding to the stated velocity. Such failures, if they should occur, would probably be restricted to local areas, and would vent the roof, relieving the internal pressure or the external suction, minimizing damage to the main framing.

Hangar doors hinged at top

To accommodate the large deflections of the cantilever, the six motor-operated steel doors are constructed with an inclined canopy 10 ft wide at the top. This canopy is hinged at the top of the vertical door leaf and also at the roof line. The top edge of the canopy is supported on trolleys running in continuous guides mounted at the end of the cantilever. Since the connection of the trolley to the canopy is hinged, the canopy is actually a flexible link connecting the door to the roof structure, the hinges easily accommodating the deflections. These doors were made by the Byrne Doors, Inc.

To provide a clear opening of 270 ft, that is, the full length of the hangar, the door guides are cantilevered 45 ft—the width of one door leaf—past the ends of the roof. The large roof deflections made it impractical to support the ends of the guides from the roof.

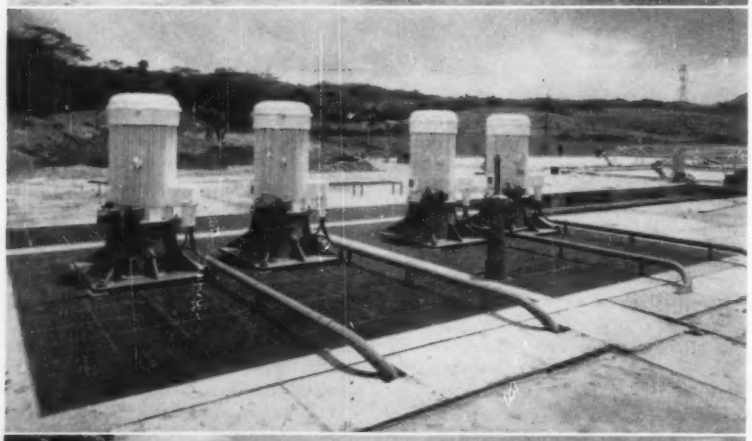
It was of course necessary to control the elevation of the outer end of the ribs quite carefully, and to erect them in properly cambered positions to provide for the additional loads imposed after cables were tensioned. The cambers had also to reflect the effects of the cantilevered door guides on the outer ribs of the roof structure. The girder supporting these guides is in effect supported on a series of springs (the main ribs), and the effect of the girder reaction is felt some distance beyond the end ribs. However, it was relatively simple to compute the proper cambers to account for this effect, and there was no difficulty in erecting the ribs to the proper cambers.

The basic soundness and simplicity of the design of TWA's Philadelphia hangar, plus the careful planning of the firms concerned, contributed greatly to the relative ease of erection.

Design and construction firms for this hangar were the Ballinger Company of Philadelphia, architects and engineers; Ammann & Whitney of New York, N.Y., consulting engineers; Baton Construction Corporation of Philadelphia, general contractors; and the Lehigh Structural Steel Company of Allentown, Pa., steel fabricators and erectors.

Caracas water supply lifted 3,125 ft over divide

With exhaustion of local gravity supplies, Caracas was forced to go across divide for pumped supply from Tuy River. Small diversion dam on this river is seen at top. Water is lifted 14 ft by four vertical pumps (middle view) into sedimentation tanks shown in bottom view. Pumping Station No. 1 and Power Substation No. 1 are behind tanks. Each pump in middle view has capacity of 14,660 gpm against head of 22 ft. Sedimentation tanks have capacity of two million gallons.



The River Tuy–Caracas Aqueduct, recently placed in operation, will relieve the City of Caracas, Venezuela, for many years to come, of a water shortage that has existed more or less since colonial times. Caracas possesses one of the finest climates in the world. It is located about six miles from the Caribbean coast, in a narrow valley, at an elevation of about 3,000 ft above sea level. However its location induces a rather difficult problem in municipal water supply. There are very few watersheds within a reasonable distance where water can be collected, stored for the six-month dry season characteristic of the tropics, and then fed to the city by gravity.

The difficulty of securing an adequate water supply has been increased by the phenomenal growth of the city. In the ten years since World War II, the population of the metropolitan area has grown from about 350,000 to something over a million.

In the 1940's the water problem was solved temporarily by the construction of two dams, one at Mariposa, six miles south of Caracas, the other at Agua Fria, some 18 miles to the southwest. The reservoirs back of these dams could store 12,500 acre-ft, and this system, together with wells and other small sources, was able to supply the city with approximately 46 mgd.

Water from another watershed

Before this system was completed it was realized that another source of water would have to be found, and studies were initiated. It was finally decided that the surrounding country had been wrung dry of all the available gravity supply and that a pumped supply would have to be developed. The source selected was the River Tuy

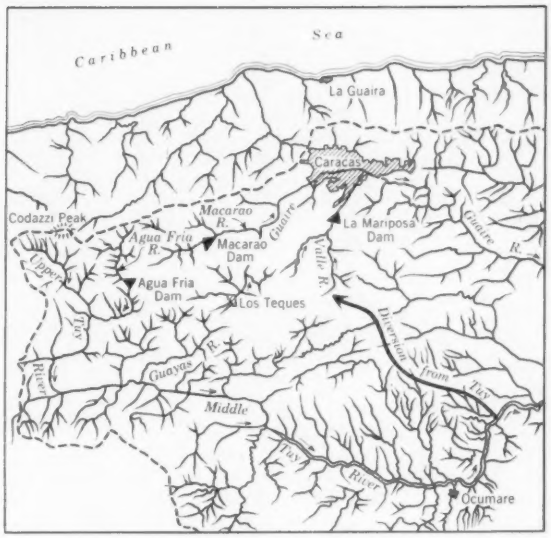


FIG. 1. New Caracas water supply is pumped from Tuy River through mountains to flow by gravity down Valle River into Mariposa Reservoir.

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E. C. COLE

Supervisor of Mechanical and Electrical Engineering, INOS

at a point about 25 air miles to the southwest of the city, at El. 400. See Fig. 1.

A small dam was constructed on the river, and four vertical pumps were installed to lift the water about 14 ft into a concrete settling reservoir with a capacity of two million gallons. The pumps are mixed-flow type, manufactured by Sulzer Brothers of Switzerland, each with a capacity of 14,660 gpm against 22 ft of head, driven by 100-hp Siemans-Schuckert motors at 580 rpm. The operation of these pumps is automatically controlled by the level of the water in the wet well at the end of the sedimentation tanks, through a Foxboro Indicating Rotax differential pressure controller.

Provisions are made for the injection of CO_2 and chlorine into the water as needed.

From the wet well following the sedimentation tanks, the water flows under 6 ft of head to the first of the four pumping stations. Each station contains four Sulzer two-stage horizontal centrifugal pumps, each with a rated capacity of 13,550 gpm against a head of 833 ft, driven by 3,500-hp Siemens-Schuckert synchronous motors—6,000 volts at 1,500 rpm.

Four pumping stations

Station No. 1, at El. 435, delivers a maximum of 55,000 gpm through a 48-in. steel pipe, 4.6 miles to a 125-ft equalizing standpipe at El. 1150, where the water flows by gravity 4.5 miles to the intake of Station No. 2. Floating on the line at the entrance of Station No. 2 is a rectangular concrete regulating tank 100 ft X 55 ft, and 17 ft deep, at El. 1140.

Station No. 2, at El. 1115, delivers the water 1.6 miles to the second standpipe at El. 1930, whence it flows 2.6 miles to the regulating tank floating on the suction side of Station No. 3. This tank, at El. 1900, is cylindrical, 19 ft 8 in. in diameter and 56 ft high.

Station No. 3, at El. 1885, sends the water to Station No. 4, 0.9 miles away, at an altitude of 2,740 ft. Midway between these stations is a $6^1/_2$-ft tunnel 610 ft long and a 62-ft standpipe. The regulating tank at Station No. 4 is the same as that at Station No. 3, 19 ft 8 in. in diameter but only 46 ft high.

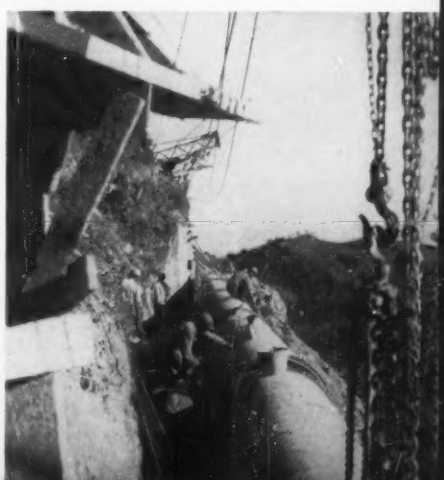
Station No. 4 delivers through a pipeline one-half mile long to a standpipe 82 ft high at El. 3565, whence the water flows by gravity another 3.1 miles to the final tunnel $6^1/_2$ ft in diameter and 1 mile long at El. 3560. By this time the water has been raised 3,125 ft and carried overland some 18 miles. The tunnel discharges into the headwaters of the River Valle, which leads to the Mariposa Reservoir about 3.1 air miles nearer Caracas.

The terrain through which this pipeline passes, especially the last half, is extremely mountainous. Station No. 4 had to be placed on a 50-percent slope, and at times the pipeline had to be laid at a slope of more than 100 percent. Taking into consideration this factor, plus pipe friction, difficulties in transportation and other factors, it was decided that a 48-in. pipe would be needed to carry the 55,000 gpm to be pumped. However, pipe with a uniform outside diameter of $1^1/_4$ meter ($49\ ^1/_2$ in.) was selected to accommodate Dresser couplings of uniform diameter. This type of coupling was selected in lieu of welding and proved to be convenient besides resulting in a saving of time and money.

The steel piping varies in thickness from 10 to 17 millimeters (0.4 in. to 0.67 in.). Each 8-meter section ($26^1/_2$ ft) was tested at the factory at 150 percent of the working pressure, then coated inside with a bitumastic lining and on the outside with a mixture of asphalt and spun glass. The pipe was supplied by Mannesmann of Dusseldorf, Germany, and generally speaking arrived in excellent condition.

Except for some one hundred points where the pipeline crosses a valley or watercourse, it is buried in the ground and covered over. The more than 100 bridges which were necessary consist of concrete columns spaced two pipe lengths apart, or $52^1/_2$ ft, with the intermediate joint welded. About 200 elbows of

Rugged country through which pumped diversion passes is typified by this side-hill cut on a bend. Steel pipe with outside diameter of $49^1/_2$ in. and Dresser couplings were used throughout pressure system.



varying angles were necessary to take care of the vertical and horizontal curvature. There are 31 automatic air vents at the high points and 33 blow-off valves at the low points. All elbows and tees are anchored in concrete blocks.

Power for pumping

A part of this project consists of a transmission line to carry energy to the pumping stations. This is a double circuit line with ACSR conductors (aluminum cable, steel reinforced) of 266,880 circular mils, 23 miles long. The principal source of energy will be the new 75,000-kw steam plant being constructed by the Corporacion Venezolana de Fomento on the shores of the Mariposa Reservoir. This energy will be at 50 cycles, 115 kv. For starting up the system and possible future emergencies, the Electricidad de Caracas ran a copper line of 350,000 circular mils from their substation in Catia to the Mariposa. They supply off-peak current at 66,000 volts, 50 cycles. Power cost varies from 3.6 to 12 mils per kwhr, with a probable average of 5 mils.

At each of the four pumping stations there is a substation furnished by the AEG (General Electric Company of Germany). Stations Nos. 2. 3, and 4 have two 7,500-kva transformers and Station No. 1 has two of 8,200 kva each.

The primary voltage is either 66 kv or 115 kv and the secondary is 6 kv. The main circuit breakers are of the outdoor air-blast type. Either transformer can be connected to either of the two circuits by disconnectors, normally interlocked, so that each transformer is connected to a different circuit.

The 6-kv metal-clad switchboard, furnished by Siemans-Schuckert, is divided into two sections so that each transformer supplies two of the main motors. There are two station transformers of 55 kva and 75 kva respectively—Siemens-Schuckert "Clophen" filled, 6,000/208 at 120 v, each connected to one end of the 6-kv bus. The secondary circuit has a two-way switch which changes over from one transformer to the other in case of an interruption in the primary voltage.

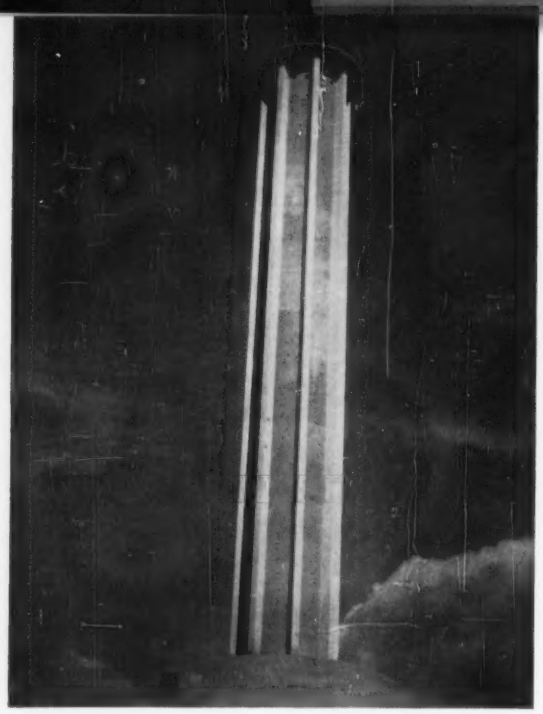
The 6-kva interruptors, air operated, are controlled by a series of panels at the main control board energized by 110-v cadmium-plate storage batteries.

Automatic control required

As there is practically no storage at the three intermediate stations, it was necessary to synchronize the operation of the system hydraulically and to provide automatic control at Pumping Stations 2, 3 and 4. Automatic starting of the four units in each of these stations is arranged for by installing a pitot tube in the pipes near the entrance of each station, just ahead of the take-off to the regulating tank. This pitot is connected through Foxboro Rotax pressure indicators to the switchboard and starts the four units through successive increments of increased flow in the pipeline. The 3,500-hp synchronous motors are thrown directly across the line. They come up to synchronous speed in about 10 sec and automatically go into synchronism. As soon as this occurs, the motor-operated gate valve, furnished by Cocard of France, begins to open, and about 10 sec later the flow in the line increases sufficiently to start up an additional unit in the next station.

The stopping of the units in Stations 2, 3 and 4 is controlled by Foxboro pressure controllers connected in the take-off to the regulating tank. As the level drops in the tank to predetermined points, one motor after another cuts off the line. In Stations 1 and 2, the gate valve closes first and then the motor trips off, but in Stations 3 and 4 the water level in the tank drops too rapidly to wait for the valve to close, so the motor cuts off and then the valve closes.

A float device is installed in each regulating tank, furnished by Siemens-Schuckert, which transmits an indication of the water level in the tank to the water control panel in the switchboard. In addition this device has a safety switch which stops all units should the water level drop too far, and rings an alarm if the level goes too high.



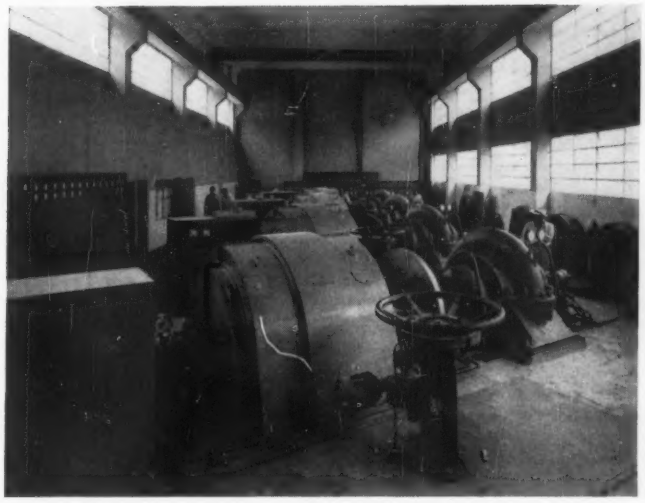
Equalizing standpipe 125 ft high was erected midway between Pumping Stations 1 and 2. This standpipe is at El. 1150, that is, 715 ft above Station No. 1 and 10 ft above regulating tank 4.5 miles away, at Station No. 2.

Each pumping unit has a Venturi meter in the discharge pipe, and an additional 48-in. Venturi is located at the entrance of Station No. 2. The water control panel of the control board has recording instruments which indicate on the same chart the input to each motor in kilowatts and the flow rate of the corresponding pump in liters per second. There is also a graphic record of the pressures in the intake and discharge manifolds of the station, and the total delivery of the system.

In addition to automatic control of the units, a system of remote control from Station No. 1 is provided. In this station there is a water control panel for each of the four stations. These panels give information as to the level of the water in each regulating tank, which unit or units are operating in each station, and the position of all valves and switches. All main interruptors can be opened or closed, and all units can be stopped or started from these panels. The impulses for these indications and controls are brought in over the 115-kv transmission line by carrier current, actuated by a 24-v battery. Incorporated in this system is telephone communication between all four stations. This system was furnished by Siemans-Halske of Germany.

As the discharge lines between the stations and the intermediate equalizing towers are quite long, especially in Stations 1 and 2, some means had to be

Steep mountainous terrain complicated building of Pumping Station No. 3, shown under construction. At times pipe had to be laid on 100-percent slope.



Each station is equipped with four Sulzer two-stage horizontal pumps, driven by 3,500-hp Siemens-Schuckert synchronous motors. In this station, No 3, note switchboard for automatic control at left.

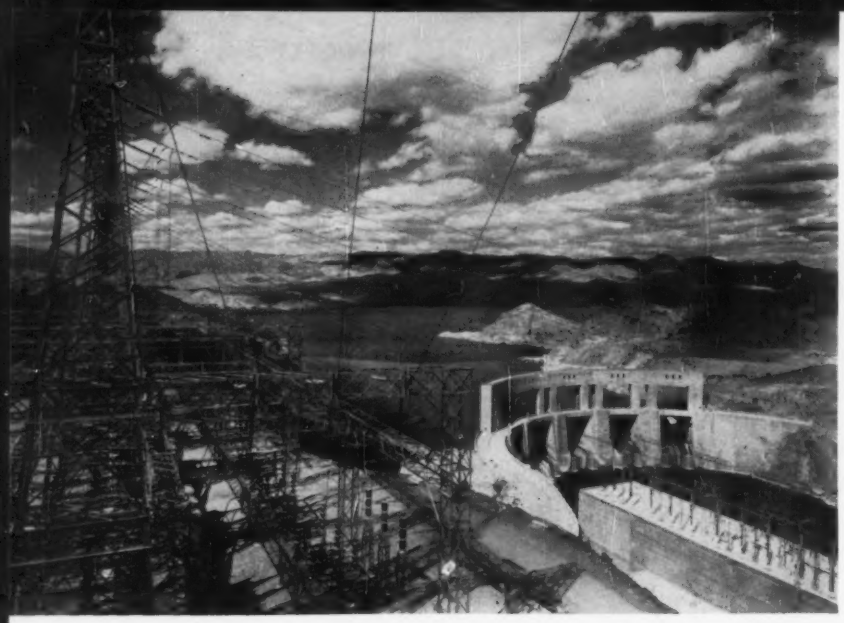
provided to ameliorate the effects of water hammer, especially in case of a power failure when two or more pumps stop at the same time. This is taken care of in Station No. 1, which has $4^1/_2$ miles of pipe in the discharge line before the surge tower, by installing, at the outlet of the station, four surge tanks with a total volume of 2,825 cu ft. The upper half of these tanks is filled with air. Constant volume is maintained by an air compressor.

Station No. 2 has approximately 1.6 miles of discharge line and has correspondingly smaller surge tanks, of 1,270 cu ft. Stations 3 and 4 have relatively short discharge lines, 2,560 ft and 2,950 ft respectively, so air vessels were not deemed necessary at these stations. Instead, the pumping units were provided with steel flywheels, approximately 3 in. X 5 ft, as a part of the flexible coupling. This added inertia allows the column of water to come to a gradual stop and alleviates the water hammer.

This pumping system, which was turned over to the INOS (Instituto Nacional de Obras Sanitarias) on August 3, 1956, 18 months after the signing of the contract, is one part of a $60,000,000 program for completing and extending the Caracas water system. Other phases consist in enlarging the Mariposa treatment plant from 14 to 100 mgd, building an additional treatment plant at Las Adjuntos, and a complete revamping of the distribution system.

All engineering and supervision were done by the personnel of the INOS. Dr. J. G. Pieretti was the Chief Engineer. The structures and supervision of the intake and sedimentation tanks was under the control of Dr. J. M. Moreau. Dr. George Vinay designed and supervised the pipeline, and Manifred Nicklas has charge of the design and construction of the tunnels. The mechanical and electrical engineering was supervised by Ernest C. Cole.

The various contractors and subcontractors were as follows: Construcciones Industriales en Ultamar, General Contractor; Wannoni y Lacayo, pipeline, three pumping stations, and three substations; Grunbilf de Venezuela, tunnels and treatment plants; CEICA (Construcciones Electricas e Industriales), transmission line; RICCA (Representaciones y Construcciones C. A.) and COVENIN (Venezuelan Company of Engineering), intake at river, sedimentation tanks, Pumping Station No. 1 and Substation No. 1.



View of Parker Dam on Lower Colorado, in California, shows dam, powerhouse, Lake Havasu, and lower 161-kv switchyard.

Multiple-purpose river basin development by USBR

Policies and projects—past, present, and future

W. A. DEXHEIMER, M. ASCE

Commissioner, U. S. Bureau of Reclamation, Washington, D. C.

The future of multiple-purpose river development, whether in this country or other parts of the world, will depend to a large degree on the economic requirements of our expanding population and the technical requirements for water supply for uses in municipalities, industries, agriculture, pollution control and many other needs. There is very little question but that the primary concern in most of the world today is an adequate water supply.

It should be kept in mind that the most beneficial use of the water resources of a river basin does not always mean for how many different purposes the water can be used. The real test is how many times we can use the water from the time it is deposited as rain or snow until it reaches the ocean or is lost by evaporation.

In the United States the development of multiple-purpose river projects has been based on policies and laws which vary considerably between federal agencies, and of course vary greatly among the various states. All units of river basin development in any federal program must show economic feasibility and national benefit. The benefits to the area and to the nation must be demonstrated and they must exceed the estimated cost of the works. These principles do not necessarily follow in other countries, although the general philosophy, I think, must always be the same.

Salt River Valley Project

Long before the white man came to this continent, primitive Indians had dug canals in the Gila River basin and the Salt River Valley. The first known irrigation on the North American Continent occurred in what is now southwestern Arizona. The need for water storage in the Salt River Valley after the white man came resulted in the construction of the first major multiple-purpose dam and reservoir in the United States. This was the Roosevelt Dam, completed in 1906 by the Bureau of Reclamation. Since that time, the Bureau and the Salt River Valley Water Users' Association have added additional facilities until today the Salt River is probably the most controlled and utilized stream in the United States. The Salt River Project is an example of maximum water and land conservation and development in a small drainage basin. The original investment of federal funds has been repaid, and repayment of later additions and improvements is now in progress.

We have recently completed an economic survey which clearly demonstrates the overwhelming worth of projects such as this to the local and national economy. The Phoenix area, which is dependent upon the Salt River system for its water supply, returns to the Federal Government in income taxes alone, each year, more money than has been invested by the Federal Government in the reclamation project.

Colorado River Basin

This same principle of multiple use has been expanded to the Colorado River basin, of which the Salt and Gila are tributaries. I believe that the future course of multiple-purpose river development will largely follow the pattern of integrated operation and use which is now well established for the Colorado. I must emphasize, however, that there is no single pattern of development which fits all river basins. There are different plans in operation even on the Colorado. We must adapt the overriding objective of maximum use to fit the varying circumstances and needs of the particular basin.

A multiplicity of problems are involved in the development of a major river basin. In the West, where water is so essential, one of the most important details is who owns the water. After extended negotiations, six of the states involved in the Colorado basin entered into a compact in 1922. This compact essentially divided the river into the

upper and lower basins, with the dividing point at Lee Ferry, Ariz. The four upper basin states subsequently, in 1947, apportioned their portion of the water by compact.

The pattern of peaceful solution of the rights to the use of water by entering into compacts is perhaps the most necessary first step toward development of any major river basin. A treaty between the United States and Mexico apportions a share of Colorado River water for Mexico. Negotiations are under way on many interstate streams in the United States and on many rivers crossing the boundary of the United States and Canada. It is impracticable to plan river basin development until reasonable assurance is available of each affected state's legal right to use the water.

Lower Basin of the Colorado

The multiple-purpose development of the Colorado River commenced with the construction of Hoover Dam in the lower basin. Lake Mead, the reservoir behind Hoover Dam, is the largest artificial lake in the world, with 30 million acre-ft of storage, or sufficient to cover the State of New York to a depth of one foot. The power plant at the toe of the dam, with 1,354,300 kw of installed capacity, was at one time the largest single hydroelectric installation in the world. A legal prerequisite to construction of the dam was contract commitments for the sale of electrical energy which would guarantee the repayment of the power investment in 50 years.

The project authorization specified that storage in Lake Mead should be used first for river regulation, navigation, and flood control, second for irrigation and domestic uses, and third for power. National policy and laws governing river basin development have largely evolved since passage of the Boulder Canyon Project Act. Flood control, navigation, and national aspects of fish and wildlife enhancement, have been considered national benefits for which no reimbursement was ordinarily required. Numerous other benefits have also been considered nonreimbursable under special authorizations. They include recreation, sediment control, salinity repulsion, and pollution control. Much present thinking, however, favors cost sharing proportionate to the benefits received.

However, the portion of project cost allocated to irrigation is reimbursable without interest on the federal investment, as enunciated in the original Reclamation Act of 1902. The costs of municipal water supply and power development are returned to the federal treasury with interest. In addition, power revenues help to carry some irrigation costs which are beyond the ability of the irrigators to repay, usually within a 50-year period. There are, of course, many complications in individual areas which require specific legislation.

Although flood control was one of the major purposes of Hoover Dam, it was built with a minimum allocation of $25,000,000 for that purpose. This $25,000,000 is to be repaid after June 1, 1987, as the Congress may determine. There has not been a flood of any consequence below Hoover Dam since it was built, although a runoff of flood proportions has been recorded above the dam several times. At the same time, we have made good use of snow surveys and precipitation data so that maximum use has been made of all available water. Except for testing purposes, no water has been passed over the spillways. Downstream consumptive needs have been supplied even during the last three years of severe drouth.

Since the completion of Hoover Dam, the Bureau of Reclamation has constructed three more downstream structures—Davis, Parker and Imperial dams. Davis is a reregulating and power structure. Parker Dam forms the forebay for southern California's Colorado River Aqueduct and supplies power to the system. Imperial Dam is a diversion structure for irrigation water for California and Arizona. Morelos Dam diverts water to Mexico. The series of dams and reservoirs has changed the lower Colorado from a most unruly and notoriously bad actor among our major rivers to a fully controlled and useful resource.

The Bureau of Reclamation, in planning, construction, and operation of the various phases of development, dealt with individual agencies rather than with any over-all agency representing the states. It might appear that the Lower Colorado River basin has been developed without too much integrated planning or an exact blueprint of the total program, but our experience would tend to refute this. Despite its unit-by-unit authorization and construction, it is notable for efficient operation and maximum utilization of available water and land resources. This has been accomplished by the integration of new projects into a gradually evolving plan of river operation which is based on surveys going back many decades before the first construction was initiated.

Upper Colorado River Basin

The approach to the development of the Upper Colorado River Basin has been on a somewhat different basis. The first step by the Upper Basin States was to reach agreement among themselves on allocation of the available water. Then an organization representing the four states, the Upper Colorado River Commission, was formed to deal with the Federal Government in developing a basin-wide plan for water use. Planning was complicated by the necessity of providing an unusual amount of storage space to meet downstream compact commitments. The vast and comparatively unpopulated area of the upper basin is truly America's last great frontier of settlement opportunity.

The initial phases of this project, which calls for the multiple-use of the water resources of the Upper Colorado, were authorized by the Congress in the spring of 1956. The authorized plan calls for four major storage reservoirs with a total capacity of more than 31,000,000 acre-ft. Glen Canyon Dam and Reservoir, which will be the principal regulating unit for the delivery of water to the lower basin, will approach Hoover Dam and Lake Mead in size and storage capacity. The backbone storage system will have about 1,098,000 kw of hydroelectric generating capacity.

Through a basin account, revenues will flow into the Treasury in repayment of reimbursable phases of the project. All funds will be appropriated each year by the Congress as they are on other projects. Because of high-cost construction, none of the participating irrigation units will be able to completely repay themselves financially. Nevertheless, the need for them is clearly domonstrated if this "last frontier" is to be opened up as a prosperous contributing segment of our economy.

Even though there was a basin-wide approach to the development of the Upper Colorado River Basin, as contrasted to the step-by-step approach in the lower basin, we are not waiting to learn the exact, minute details of every phase of future need and work. We have a broad general concept of multiple-purpose development and a basin-wide approach to financing. We are preparing to start work on the initial phases and will fit other phases in as the need develops. Thus, plans are remaining fluid in undertaking this multiple-purpose development which will require several decades to accomplish.

Central Valley Project

The Central Valley Project of California demonstrates the need not only for planning a multiple-purpose development on one watershed, but for combining watersheds to provide maximum water use. Here, the major rivers have

a common outlet to the ocean in San Francisco Bay. Surplus flows rise in the high mountains to the north and east of the great Central Valley causing considerable destruction during the flood season of fast-melting snow and unusual, heavy rains. A major part of the year, however, the streams are nearly dry and there is very little precipitation in the whole valley. Most of the major streams have been controlled, hydroelectric plants have been installed, and canals carry the water to highly productive farmlands.

In the San Joaquin, or southern part of the Central Valley, the growing season is 11 months of the year and this is the most water-deficient part of the basin. Coordination permits pumping of excess flow from northern streams to the south, where the supply is far short of the demand. Exchange and replacement are fundamental principles of the Central Valley Project. To these have been added the transmountain movement of water by the Trinity River diversion now under construction.

Numerous structures on streams in the Central Valley were built and operated by different agencies, some federal, some local, and some private. The closer these assorted facilities can be integrated into an operating whole, the greater will be the potential of beneficial use.

Columbia River Basin

In the Columbia River Basin, development has been by three-way cooperation. The Corps of Engineers has largely concerned itself with the downstream work in which flood control and navigation predominate. The Bureau of Reclamation has worked upstream and on the tributaries, building structures to hold the spring snowmelt as far upstream as possible so that the water would be available for irrigation in the late summer and fall and for power generation. Public utilities are constructing structures whose primary function is power, although they too may have associated benefits.

Congress has authorized the construction of some irrigation projects which will have the assistance of power revenues from unrelated federally constructed hydroelectric facilities. The Government is also studying the possibility of pooling power revenues to assist in further multiple-purpose development without undue drain on the federal treasury.

This basin is one of the few areas in the Western United States which is blessed with an abundance of water, rich land, and an extraordinary hydroelectric potential which has been only partially realized. I foresee an extraordinary development in the Pacific Northwest in decades to come as these three elements—land, water and energy—are utilized. There are only two provisos I would make in qualifying this forecast. One is that ample provision be made for integration of facilities into the over-all operating plan of the river, regardless of the constructing agency. The other is that some provision be made for the application of power revenues to help amortize the cost of other development work.

Valuable incidental benefits

In this résumé of western basin development, principal emphasis has been placed on water for consumptive uses, power generation, flood control and navigation. It is not my intention to ignore the other benefits which are being realized from multiple-purpose development. As an example, we have recently completed a survey of the use being made of Bureau of Reclamation facilities for recreation purposes. It appears that we will have some 10,000,000 visitors at our dams and reservoirs this year. While we can't measure the value of human enjoyment in outdoor recreation, we do have something of a yardstick in the amount of money these visitors will spend.

Although we all know that few fishermen get by on $6 per day, we have fixed that figure as the most likely average daily expenditure of all recreation seekers at our facilities. This comes to an annual expenditure of $60,000,000—a not inconsiderable addition to the marts of trade.

Then there are such benefits as salinity control, replenishment of ground water supplies, and pollution control, all of which are becoming increasingly important. It is probable that the soil conservationist and the big-dam builder will work together much more closely in future decades, for their work is equally important. The range management specialist and the forester have proved that they conserve water for consumptive use by proper management of the vast areas of forest and stock

Davis Dam, in Arizona, also on Lower Colorado River, seen from downstream in aerial view, was built for regulating and power purposes.

First major multiple-purpose structure to be built was Roosevelt Dam, on Salt River, here seen with spillways overflowing. It also is part of Lower Colorado development.

rangelands. Soil stabilization is important not only for the land itself, but because erosion control will extend the useful life of water storage reservoirs by centuries, and will decrease silt deposition in rivers and harbors.

Doing something about the weather

The Advisory Committee on Weather Control is studying the matter of doing something about the weather. In its first report, released in February 1956, this committee reported statistically significant increases in precipitation in selected experimental areas in the mountains of California. Such increases amounted to from 9 to 17 percent of the precipitation during favorable periods. Naturally the investigators selected for their first studies areas where they expected the best chance of finding such increases.

These findings do not provide any information as to what can be accomplished in other areas or at other seasons, and a great deal more work will be required before we know what is practical along this line. If practical, economical, and safe, this could be an effective tool. Even minor increases in precipitation, if extended over a large watershed, could produce a considerable quantity of water. The logical time and place for wringing additional water out of the skies is in the mountains in the wintertime. This would automatically increase the need for reservoir storage space. However, to date, this is a questionable process.

The United States is not alone in its need for comprehensive basin-wide development of its water resources. The Bureau of Reclamation has found through its advisory work with other governments, that a comprehensive approach within nations and between nations is the most effective way to utilize water resources.

The Australians are offering an admirable illustration of interstate cooperation in the execution of their Snowy Mountains plan. There the waters of the Snowy River, now flowing through Victoria to the sea, will be diverted through the mountains into the basins of the Tumut and Murrumbidge to the River Murray, which traverses Victoria, New South Wales, and South Australia. These diverted waters will create great quantities of hydroelectric power, improve navigation, and irrigate thousands of acres. The Australians are well along on this project.

The Mekong River in southeastern Asia has capabilities approaching those of the Mississippi but its development on a multipurpose basin-wide basis will require cooperation among four countries—Thailand, Laos, Cambodia, and Viet-Nam.

Future trend predicted

In summary, I anticipate that an even greater emphasis will be placed upon multiple-purpose basin development in the future than in the past. The complexity of trying to build large storage works in river valleys with dense population requires a different approach than in a comparatively undeveloped basin. In many of our river valleys, large storage works are excessively expensive in terms of right-of-way costs and valuable property inundated. We must move back to the upper reaches and perhaps replenish underground waters. As the pressure for water grows, I anticipate there will be an expansion of projects diverting water from one basin to another.

Reforestation, small holding ponds, adequate soil conservation practices, and watershed management must be emphasized as supplementary measures but we must have more knowledge of the effect of these programs. If well planned and consistently carried out, these measures will undoubtedly help conserve water where it falls, both for water conservation and for flood protection.

I anticipate greater local and state participation in planning, construction, and operation of multiple-purpose facilities, although by the very nature of interstate rivers and the problems connected with their development, strong national leadership is essential. This, I am sure, will continue to be forthcoming, just as this nation will continue to set the pace and provide a pattern for other nations in raising their economic status by proper development and use of their natural resources.

(This article is a shortened form of the paper presented by Mr. Dexheimer at the ASCE Knoxville Convention, in the Symposium on Multiple-Purpose River Development, before the General Technical Session, presided over by C. E. Blee, Chief Engineer of the TVA.)

Imperial Dam on Colorado, near Yuma, Ariz., is diversion structure for Gila Canal on near side, and All-American Canal on far side. Note desilting basins for water entering latter canal.

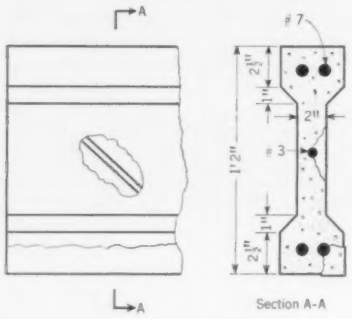
Hoover Dam, which inaugurated the era of great masonry structures, is seen from air, with Lake Mead extending into the distance behind it.

CORRODED REINFORCEMENT

destroys concrete beams

CARL L. SHERMER, M. ASCE, Professor of Civil Engineering, Michigan State University, East Lansing, Mich.

FIG. 1. Reinforcing bars, expanded by oxidation, burst beam concrete exposed to warm moist air in lumber drying kilns.



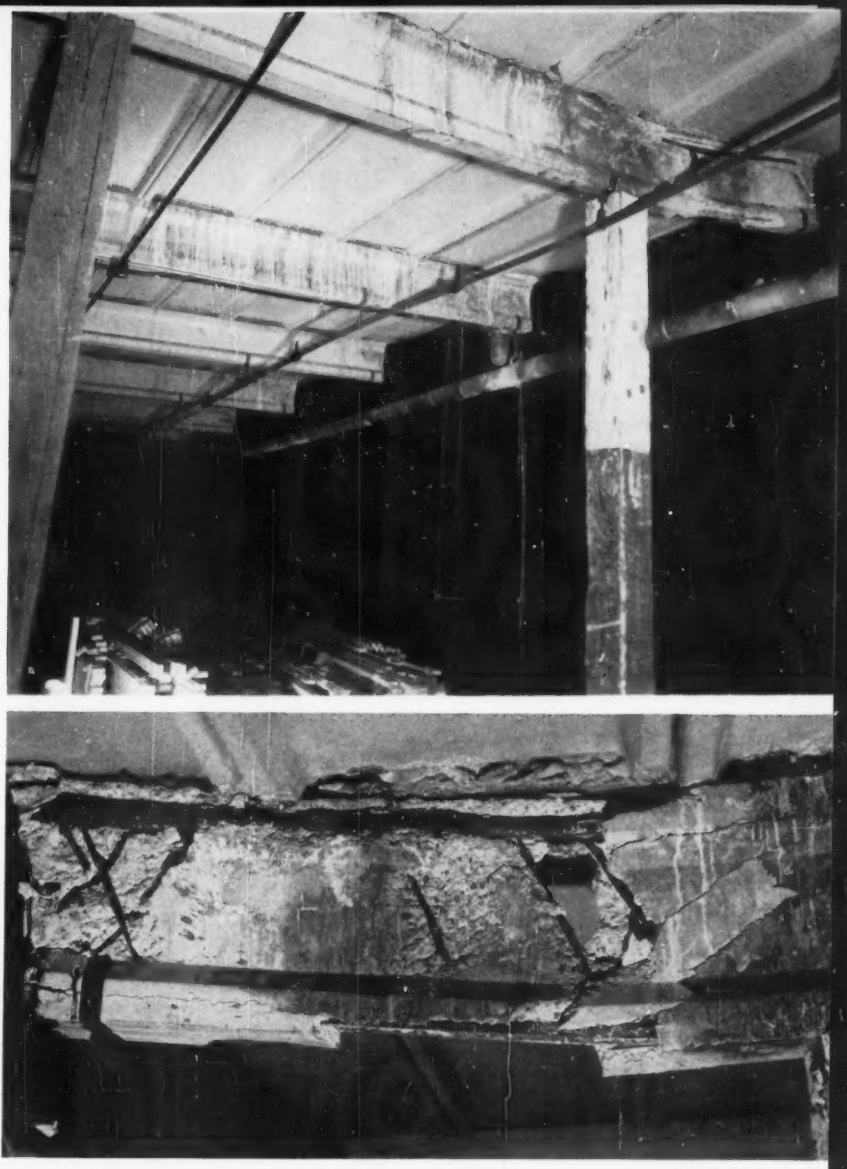
Corrosion of reinforcement has recently caused the failure of a number of precast I-type beams supporting the roof of lumber drying kilns at the Brunswick-Balke-Collendar Company plant at Muskegon, Mich. The beams were exposed to the warm moist atmosphere inside the kilns, and the only protection for the reinforcement was that provided by the concrete of the beams themselves—which is usually not much in this type of beam. The kilns were built in 1947 and corrosion proceeded at such a rate that, in some of the beams, bars of $^{7}/_{8}$-in. diameter were reduced to $^{1}/_{2}$ in. or less by the summer of 1955. Failure occurred under the dead load of the roof only.

Of particular interest was the way in which the beams failed. Although the concrete was of fair quality (small specimens cut from the beams tested between 3,000 and 4,000 psi), the steel had so little covering that both moisture and air evidently penetrated readily. The steel corroded, and because the oxide occupied a larger volume than the steel, the bars increased in size and literally burst the beams, as shown in Fig. 1. The longitudinal steel caused very noticeable cracks, which often extended the full length of the beam along one or more faces of the flanges. The $^{3}/_{8}$-in. diagonal web bars in several cases simply popped the concrete from one face of the web, leaving the steel exposed as shown.

Although the manner of cracking left little doubt that it was caused originally by bursting due to corrosion of the steel, it progressed far more rapidly near the ends of the beams than at the center. The best explanation for this seems to be that although the primary cause of the cracking was bursting due to steel corrosion, the cracks progressed as a result of other causes also, and they progressed most rapidly where

Horizontal cracks in flanges of concrete beam indicate start of trouble caused by corrosion of reinforcing.

Expansion of iron oxide in corroded web reinforcing literally popped out concrete of beam.



Beam failure occurred at points of high shear, probably because of slippage of corroded reinforcement. Lumber being cured is seen in background of upper photo. Closeup shows beam in foreground from other side.

the shearing stresses were greatest and where there was some slipping due to loss of bond. In each case where ultimate failure occurred, this failure was close to the support.

The roof deck of the kilns consists of precast concrete slabs of channel shape lying with the flanges pointing downward. These slabs showed absolutely no sign of deterioration. They were cast in the same factory at approximately the same time as the beams. However, chips cut from the slabs showed a much sharper break passing through rather than around the aggregate, indicating a much better quality of concrete. It is likely that the difficulty of casting the narrow beams, especially when the volume of steel was so great, resulted in the use of a wetter mix and hence in more porous concrete, permitting easy penetration of both air and moisture.

The concrete floor, like the roof slabs, showed no sign of cracking or disintegration. This fact also supports the conclusion that it was not the vapor driven off of the lumber which caused the concrete to deteriorate, but rather steel corrosion which initiated failure.

It has been reported that similar use of precast concrete beams in kilns has been entirely satisfactory where the beams were given a coating of waterproofing compound. This again confirms the diagnosis.

The kilns were repaired by replacing the beams that showed the greatest amount of damage. Others were given a static load test equivalent to approximately twice the live load. This was done by running a loaded tote box under the beam of a lift truck. A chain was thrown over the beam at the quarter point and attached to the box. The lift was then lowered so that the box hung from the beam. Deflection and recovery were measured carefully. The concentrated load was placed at the quarter point so that the maximum moment and shears would be approximately the same as those in a uniformly loaded beam.

After the testing of doubtful beams and the replacement of those shown to be bad, the cracks in all the beams were grouted. Then the under side of the whole roof structure, consisting of beams and slabs, was given two spray coats of asphaltic waterproofing. It is believed that the structure will now have a normal or near-normal life expectancy.

The facts of this job, on which the writer served as a consultant, are related in order to emphasize the importance of proper protection for concrete reinforcement in damp locations. Protection for reinforcement against corrosion can be provided by one or more of the following methods: (1) use of good quality concrete, (2) maintenance of a sufficient distance between the steel and the exposed concrete surfaces, and (3) use of waterproofing applied to the concrete.

Robert L. Neff was the plant engineer in charge.

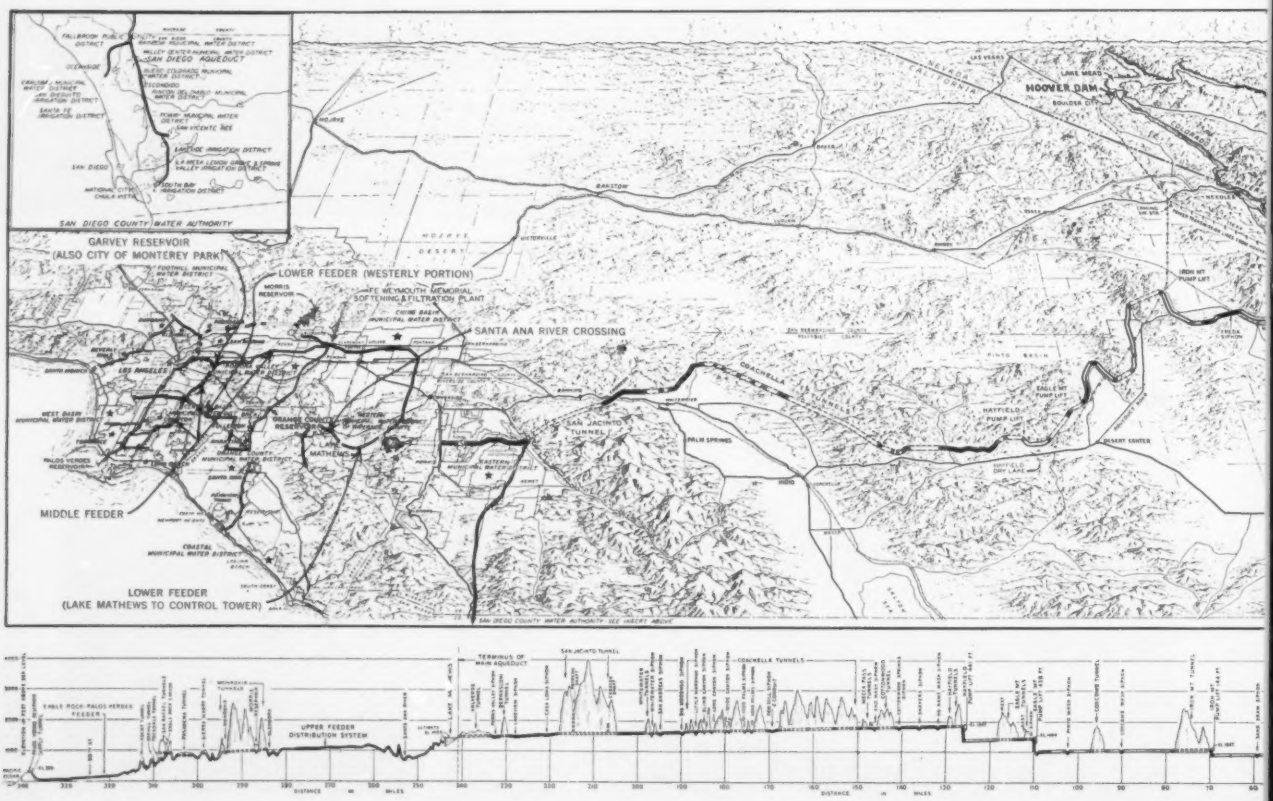
Colorado River Aqueduct

The Colorado River Aqueduct is one of the Seven Modern Civil Engineering Wonders of the United States, selected by ASCE.

The need for water to meet domestic and industrial demands in Southern California has been enormously increased in the past quarter of a century by the greatest migration of people in modern times. In December 1928, eleven cities, including Los Angeles, organized the Metropolitan Water District of Southern California in accordance with the provisions of the Metropolitan Water District Act adopted by the California State Legislature in 1927. Its purpose was to plan, finance, build, and operate a water system to deliver water from the Colorado River to the cities and areas of the District located on the coastal plain of Southern California. At the time of its organization, the District covered an area of 560 sq miles with a population of 1,600,000 and an assessed valuation of $2,200,000,000.

Planning, financing, and building an aqueduct 250 miles long across a desert area traversed by five mountain ranges was a challenge to the people of Southern California, especially the area within the Metropolitan Water District. In 1913 the city of Los Angeles had completed its Owens River Aqueduct from the High Sierras 238 miles distant. Increased water demands and lowering of water tables in the Southern California coastal underground basin made it imperative that supplemental supplies be brought in from the Colorado River as soon as practicable. In September 1931, a bond issue of $220,000,000 was submitted to the 13 cities which then made up the Metropolitan Water District of Southern California. At that time it was the largest bond issue ever submitted to a popular vote, and it was approved by the vote of nearly 5 to 1.

FIG. 1. Colorado River Aqueduct extends from diversion just above Parker Dam on Colorado River to distribution system of Metropolitan Water District of Southern California.



Construction started in 1932

Actual construction work on the aqueduct was begun in December 1932 after court litigation had cleared the way for the selling of the bonds and the financing of the program. The District engineering staff made exhaustive studies of more than fifty routes at various locations and elevations with possible aqueduct intake sites located on the

capacity being doubled to fill needs until 1980

ROBERT B. DIEMER, M. ASCE, General Manager and Chief Engineer, Metropolitan Water District of Southern California, Los Angeles, Calif.

Colorado River at points starting as far north as the section of the river above Boulder Canyon and as far south as the Mexican border. The route selected by the staff of the District and approved by an Engineering Board of Review, composed of three eminent civil engineers, has a diversion from the river about 150 miles below where Hoover Dam is now located, and 16 miles upstream from Parker, Ariz. The District made water diversion filings on the Colorado River immediately after it was organized, and entered into a contract with the Secretary of the Interior for 1,100,000 acre-ft of water from the river. Plans to carry this water through the aqueduct required a capacity of 1,605 cfs.

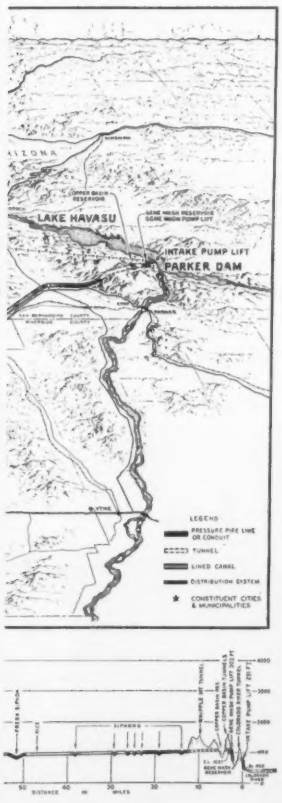
The aqueduct (Fig. 1) runs 242 miles across the state from the Colorado River to Lake Mathews, its terminal reservoir. This reservoir, located 10 miles southwest of Riverside, Calif., had an initial capacity of 107,000 acre-ft. Included in the aqueduct system are five pumping plants which lift the water a total height of 1,617 ft. In addition to the pumping plants, the main aqueduct system includes 92 miles of 16-ft-diameter tunnels, 55 miles of 16-ft-diameter covered concrete conduit, 63 miles of concrete-lined canal, 29 miles of concrete siphons, 3 dams, and 237 miles of high-voltage lines from Hoover Dam to the pumping plants.

Initially, the tunnels, covered conduits, canals, and 7 miles of siphons were built to their full capacity of 1,605 cfs, but initially only the first three of nine 200-cfs pumps were installed in each of the five pumping plants. The initial construction also included a distribution system of 150 miles of large-diameter pipelines and tunnels to deliver water to the member cities. The aqueduct was completed in June 1941 at a cost of $190,000,000, or about $22,000,000 less than the original overall estimate. The cost of building and operating the Colorado River Aqueduct is borne entirely by the people served and benefited in the Metropolitan Water District, and without federal subsidy.

Fifteen years have passed since the aqueduct was put in operation. The extended drought which has prevailed in the past 12 years (with the exception of the 1951–1952 season) together with the amazing population growth in the southland, started mass annexations to the District at an accelerated rate in 1946. Today the District includes 72 incorporated cities in the five Southern California counties of Los Angeles, Orange, Riverside, San Bernardino and San Diego. It has an area of more than 2,900 sq miles, a population of more than 6,500,000, and an assessed valuation exceeding $9,600,000,000.

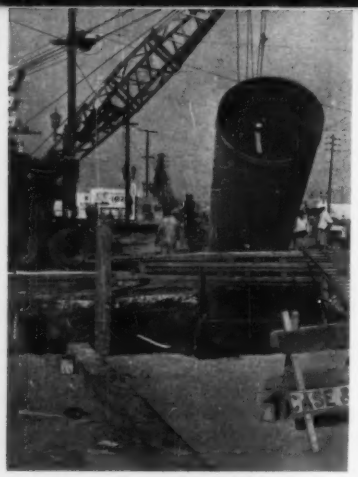
The District has made extensive studies pertaining to population trends, industrial growth, and water requirements. At the present rate of growth, the population of Southern California will be increased 3,500,000 by 1980 to a total of about 10,000,000. The present use of water in Los Angeles is 174 gal per capita per day. One acre-foot of water will serve 5 persons per year. On this basis 700,000 acre-ft of water will be required to serve these 3,500,000 people. The present requirement for Colorado River water, if facilities were available, is about 550,000 acre-ft. This makes a total water requirement by 1980 of 1,250,000 acre-ft. On this basis the Colorado River supply should be sufficient until that time unless the present dry cycle continues indefinitely. In 1946 the San Diego County Water Authority was annexed to the District and its contract for Colorado River water was merged with that of the District, giving the District a total allotment of 1,212,000 acre-ft annually from the Colorado River.

Since the completion of the aqueduct



Concrete-encased welded steel pipe of 108-in. diameter is being installed across Santa Ana River, 45 ft below river bed, while well points and pumps remove 6 cfs from working area. River flow of 45 cfs bypasses excavation.

Two lines deliver water from Eagle Mountain Pumping Plant. Recently completed line, at left, is being sprayed with water to prevent mortar lining from drying too fast.



Welded steel pipe of 79-in. inside diameter is installed in Middle Cross Feeder. Pipe is mortar lined and gunite coated.

in 1941, the District from time to time has sold bonds from its 1931 issue of $220,000,000 to provide for the construction of extensions and enlargements to the aqueduct's water delivery system. The last of these bonds recently was sold for this purpose. Interest and amortization payments on these bond issues have been provided very largely by tax money paid into the District's treasury by cities and other constituent areas within its boundaries. Several of the District's member cities have paid or are paying most of their annual assessments from funds derived from their municipal water sales. In addition to the money collected by the District from taxes and other assessments, an increasing amount of revenue is being derived from the sale of water to constituent areas. The District sells its water wholesale; it is not a retailer of water to individual domestic and industrial consumers.

To meet both the interest and amortization charges on its outstanding bonds, the District since 1932 has paid out $142,800,000 to meet interest charges, and $33,700,000 in amortization charges on outstanding bonds.

In addition to the funds available from the bond issue and water sales, additional funds are derived from the new areas annexed to the District since its organization in 1928. Areas annexed enjoy the same right to water service as the original members, in conformity with the rules provided by the Metropolitan Water District Act, upon payment of a back tax charge which includes the annual tax payments that the area would have made if it had been one of the original members, plus interest at 4 percent from the due date of each payment to the date of annexation. If the annexing area does not desire to pay this back tax charge in cash, it can be amortized at 4 percent interest over a 30-year period and paid in 30 equal annual payments. There is now a total of $170,000,000 in annexation fees that will be ning to the District in the next 30 years.

Funds from the 1931 bond issue available for construction of new facilities will be exhausted by July 1957. Drought, unprecedented population growth of the south coastal plain, and depletion of underground water basins make it mandatory that the District obtain funds immediately to provide additional facilities to bring in the full allotment of Colorado River water by 1960.

In March 1956 the State Legislature amended the Metropolitan Water District Act to enable the Board of Directors of the District to issue short-term notes to be paid off with funds received from annexation fees. These short-term notes are to be retired in a period not to exceed 12 years, and the amount of them outstanding at any time is limited to 50 percent of the annexation charges then receivable. No increase in taxes is necessary to pay off these notes. Voters in the District gave overwhelming approval to this measure by an overall ratio of 11 to 1 in the election of June 5, 1956.

Since early in 1952 the District has been engaged in a construction program to expand its facilities for pumping and distributing Colorado River water. Work authorized under this expansion program totals $85,000,000. As previously mentioned, the five pumping plants will contain nine 200-cfs units, of which three were installed initially. The fourth and fifth units have now been installed, and equipment for the sixth unit is under contract and should be installed within the next 18 months. The installation of the second of a total of three delivery lines, of 10-ft diameter, from the pumping plants to the aqueduct has been completed.

Contracts have been completed or are nearing completion on 19.2 miles of the easterly part of the Lower Feeder (capacity, 750 cfs) which ultimately will serve not only Orange County but also the coastal area in Los Angeles County. The Lower Feeder included the construction of 2.5 miles of 10-ft-diameter concrete-lined tunnel, 14.0 miles of 108-in. precast concrete pipe, and 2.5 miles of 108-in. welded steel pipe, which is mortar lined and has a gunite-protected exterior coating. An interesting feature of this feeder was the installation of the steel pipe under the Santa Ana River at a maximum depth of 45 ft. Three rows of well points were required to dry up the site at the crossing. This section of the pipe was encased in reinforced concrete 18 in. thick.

A storage basin (Garvey Reservoir) for the distribution system with a capacity of 1,500 acre-ft (about 500,000,000 gal), has been completed on the Middle Feeder. This reservoir is located in the hills in the city of Monterey Park, east of Los Angeles. It is an earth-fill reservoir with an asphaltic concrete lining placed over the compacted fill.

Contracts have been awarded for 25 miles of the Middle Feeder (capacity 250 cfs) from the Softening and Filtra- Plant at La Verne to the recently constructed Garvey Reservoir. When this work was advertised, bids were requested both for welded steel pipe of 72-in. diameter and for precast concrete pipe. Because of the shortage of steel, no bids were received on the steel pipe alternate on the last section of 3.0 miles.

Construction is under way on the westerly part of the Lower Feeder from the Orange County boundary line to a connection with the Middle Feeder. This line includes 11.5 miles of lined and coated welded steel pipe of 78-in. inside diameter.

Other lines completed in the past four years or now nearing completion are 23 miles of welded steel pipe 36 to 78 in. in diameter; and 37 miles of precast concrete pipe, 36 to 108 in. in diameter. During the past four years the second barrel of the San Diego Aqueduct, with a capacity of 85 cfs, was completed by the U.S. Bureau of Reclamation for a distance of 35 miles at the District's expense.

With funds available from the short-term notes, the District now has under way plans for installing additional facilities to bring its full allocation of Colorado River water to the metropolitan area by the end of 1960. Bids were received in September for fur-

Precast concrete pipe of 108-in. inside diameter is being installed on Lower Feeder, west of Corona.

nishing the three remaining pumps at the five pumping plants so that these will be ready for operation by June 1960. Plans for the third and last of the pump delivery lines are being prepared for early advertising for bids.

The Metropolitan Water District has a contract with the United States for 36 percent of the power generated at Hoover Dam. Also, since it paid half the cost of the Parker Power Plant, it is entitled to half of the power generated there. These two sources of power are sufficient to pump about two-thirds of the water allocated to the District from the Colorado River. In the expansion plans to bring the aqueduct to full capacity, it will be necessary to make arrangements for the additional energy and to build more transmission lines. This is also in our plans for early development.

To bring the aqueduct up to full capacity, a second barrel will be added to 47 siphons, 13 ft 0 in. and 13 ft 6 in. in diameter, for a total length of 22 miles. The terminal reservoir, Lake Mathews, will be enlarged from 107,000 acre-ft to 225,000 acre-ft. This will require the dam and dike to be raised approximately 50 ft and extended about two miles. In this work about 10,000,000 cu yd of earthfill will have to be placed. Additional pipelines on the distribution system approximating 35 miles in length, and varying from 48 to 78 in. in diameter, will be prepared for advertising soon. Included in the construction program is the doubling of the present 200-mgd capacity of the Weymouth Softening and Filtration Plant on the Upper Feeder. The present plant is operating at 50 percent above capacity for two or three months of the year during extreme hot weather.

It is estimated that about $85,000,000 will be required for this construction program above that needed for work now in progress. Following the completion of this program in 1960, additional facilities estimated to cost $75,000,000 will be required, making a total of $240,000,000 for the three programs. Income from annexation charges and profits from water sales after 1960 should be adequate to complete the program without further financing.

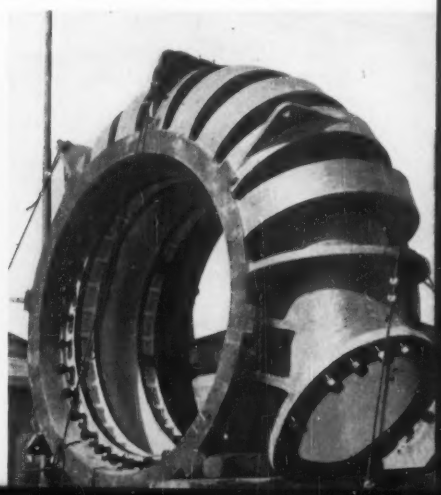
This is the story of the planning, financing and building of the Colorado River Aqueduct of the Metropolitan Water District of Southern California—the largest and longest domestic water supply line in the United States.

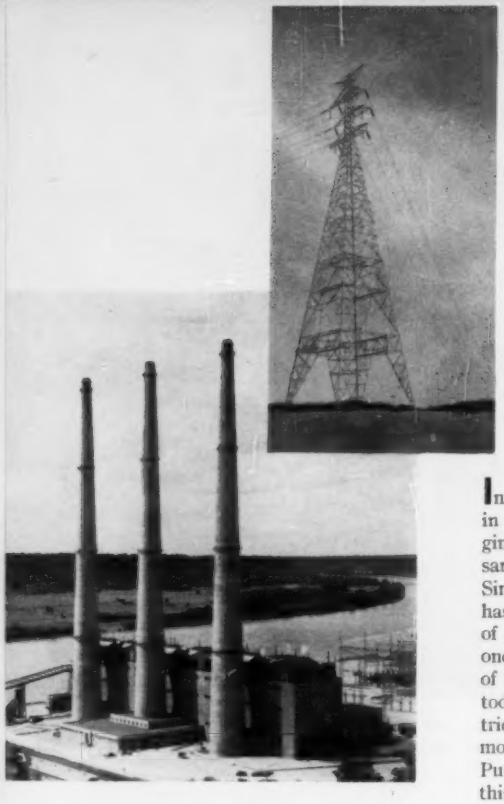
Franklin Thomas, Past President of ASCE, was a member of the Board of Directors of the Metropolitan Water District of Southern California from its inception in 1928 until his death in August 1952. The late Frank E. Weymouth, Hon. M. ASCE, was General Manager and Chief Engineer from 1929 to 1941. He was succeeded by Julian Hinds, former Director of ASCE, who served until the end of 1951. The writer, who began his service with the District in 1929, succeeded Mr. Hinds. Robert A. Skinner is at present Assistant Chief Engineer; Henry J. Mills, Construction Engineer; and Harris V. Crawshaw, Office Engineer. All are members of ASCE.

Garvey Reservoir on Middle Feeder, has recently been completed and is being filled with Colorado River water. Capacity is 1,500 acre-ft.

Ten regulating valves on Colorado River Aqueduct reduce upstream pressure of 245 psi to downstream pressure of 175 psi. This pressure-reducing equipment and structure have been installed on Middle Feeder.

Steel scrollcase weighing 16 tons is ready for transportation to one of new pumping units on main Colorado River Aqueduct.





Big steam plant at Clifty Creek on Ohio River has generating capacity of 1,300,000 kw in six 220,000-kw units. This plant of Ohio Valley Electric Corp., completed in 1956, has stacks topped out at 682 ft above grade. Current is stepped up to 330 kv for transmission 142 miles to AEC gaseous diffusion plant at Portsmouth, Ohio. Transmission towers 355 ft high (upper view) carry power cables spanning 2,608 ft across Ohio River. Each tower measures 92 ft on a side at its base and contains 120 tons of structural steel.

A power engineer

THEODORE BAUMEISTER, Stevens Professor of Mechanical

In discussing what appears to lie ahead in the next ten years—for the civil engineer in the field of power—it is necessary first to take a brief look backward. Since 1900 the electric power industry has reduced fuel consumption from 7 lb of coal per kilowatt-hour to less than one pound. See Table I. In the face of rising coal prices, this means that today the cost of coal for producing electric energy, in mills per kwhr, is no more than it was in 1900. See Table II. Put another way, if there had not been this improvement in thermal efficiency, and we were compelled today to accept the thermal performance of 1900, the entire coal producing capacity of all the nation's coal mines would be insufficient to meet the demands of the electric industry alone. There would not be enough coal for the power industry, let alone for any other uses.

This is only one item that can be cited in the march of progress, and there is no good reason to suppose that the march will be stopped in the next ten years. It cannot be as spectacular in the improvement of fuel economy but there are plenty of other areas in which progress can be made. Some people advise young engineers to shun the power field. Their advice is predicated on the belief that no more progress can be expected—just a repetition of the same old story. Those who wish to accept that view can do so. There are others who visualize many changes, and most of those changes will have an impact on the civil engineering branch of the profession. Let us look at some of the probable influences.

The fuel picture

Every rational estimate of the growth of the electric power industry indicates a doubling of the installed capacity in the next ten years, as shown in Table III. This would mean the burning of some 250,000,000 tons of coal a year, approximately half the entire bituminous coal output of the nation today (Table IV). This coal will be transported in many different ways—by rail, barge, and truck. If we assume no improvement in the methods of carrying coal, it seems as incongruous to supply coal by car or truck to a single boiler unit burning 3 or 4 tons a minute, as to use wheelbarrows instead of carryalls for moving earth, or wooden barrels instead of tank cars for transporting oil. Belt conveyor systems for crushed coal, or pipelines,

TABLE I. Overall thermal performance of U. S. electric utility power plants

Year	Overall Plant Heat Rate, Btu per kwhr (approx.)
1900	90,000
1910	60,000
1920	36,000
1930	20,000
1940	16,400
1950	14,000
1954	12,200

TABLE II. Fuel cost for generation of electricity in U. S. electric utility power plants

Year	Dollars per ton of coal equivalent	Mills per kwhr
1917	3.52	4.7
1922	5.31	6.2
1932	3.30	2.3
1942	3.80	2.5
1947	5.60	3.7
1952	6.21	3.4
1954	6.25	3.1

TABLE III. Estimated annual electric utility generation of U. S.

Projected from 1950 figure of 329 billion kwhr

Year	Billions of kwhr Based on Annual Growth of		
	4%	6%	8%
1955*	400	440	480
1960	490	590	700
1966	610	820	1,100
1970	720	1,050	1,500

* For the year 1955, the actual production was 546 billion kwhr.

looks ahead ten years

Engineering, Columbia University; and Consulting Power Engineer, New York, N.Y.

should be competitive with existing methods of moving coal—even with the electric transmission line in some areas. In considering the development of alternative methods of transporting coal it should be recognized that the present cost for transportation alone frequently exceeds the cost of the coal at the mine. This high cost of transportation is a tremendous incentive to the development of new devices or systems for moving coal more cheaply.

It is not logical to expect that, in the thermal powerhouses of the future, the size of coal bunkers will be greatly increased. Today's construction costs for bunkers, with heights of 100 ft and loads in thousands of tons, offer limitations that call for a new approach to the problem. It is reasonable to expect an extension of the current trend toward the outdoor type of power plant. Even metal and asbestos-type siding will be eliminated as was the tapestry brick and limestone trim of the old-style plants. This will introduce new structural, operational, and maintenance problems to meet the interrelated vagaries of climate, cost, and plant reliability. The figures cited on coal consumption in Table IV will stir the engineer's imagination and inspire him to seek out alternative sources of raw energy. Petroleum and natural gas should find decreasing use for stationary power applications because of cost and the increasing demands of mobile power plants. Hydro power also will become of less significance in the nation's power picture. See Table V. Some favored regions, like the Pacific Northwest, will continue their hydro development. The entire hydro potential of the country is estimated to be of the order of 100 million kw, and 500×10^9 kwhr in an average water year—if every potential site were harnessed. This complete harnessing is admittedly impossible; there are too many other needs for water.

Perhaps the most significant piece of evidence that can be found on the dwindling relative importance of hydro power is the fact that the TVA is already the country's largest coal buyer, and its purchases account for more than one tenth of all the coal used by the entire electric industry in the United States. Or again, from the viewpoint of the world as a whole, it should be remembered that "The burning of dung is a larger contributor to the world's energy than water power, in fact, ten times as large" (G. G. Brown, "Thinking Ahead: Nuclear and Solar Energy," Harvard Business Review, Vol. 34, No. 17, 1956).

Large nuclear fuel reserves

There are other sources of raw energy like the tides, the wind, the waves, and the sun, but these offer little likelihood of being harnessed in ten years, or even in fifty. But the energy in the nucleus of the atom is something else again. Many estimates have been prepared to show the magnitude of the world's nuclear fuel reserves (Table VI). Compared to fossil fuels, these reserves are at least twenty times as great, by even the most pessimistic estimates. So any atomic power plant has ample assurance of a continuing raw fuel supply, that is, in this country, if Uncle Sam is willing to let it have the fuel.

Many technical, legal, and economic problems remain to be solved before the nuclear plant will be competitive with other methods of generating power. But the time, talent, and money at present being devoted to the perfection of reliable and economic nuclear plants are sure to result in practical solutions. The only pertinent conjecture is, when

TABLE IV. Coal production and its use by electric utility power plants of U. S.

Year	Total Bit. Coal production, tons	Coal burned in utility power plants: Tons	Coal burned in utility power plants: Per cent
1902	260,000,000	4,250,000	1.6
1912	450,000,000	12,500,000	2.8
1922	422,000,000	29,000,000	7
1932	310,000,000	28,000,000	9
1942	583,000,000	66,000,000	11
1947	631,000,000	90,000,000	14
1954	392,000,000	118,000,000	30
1955	465,000,000	144,000,000	31
1956*	500,000,000	150,000,000	30

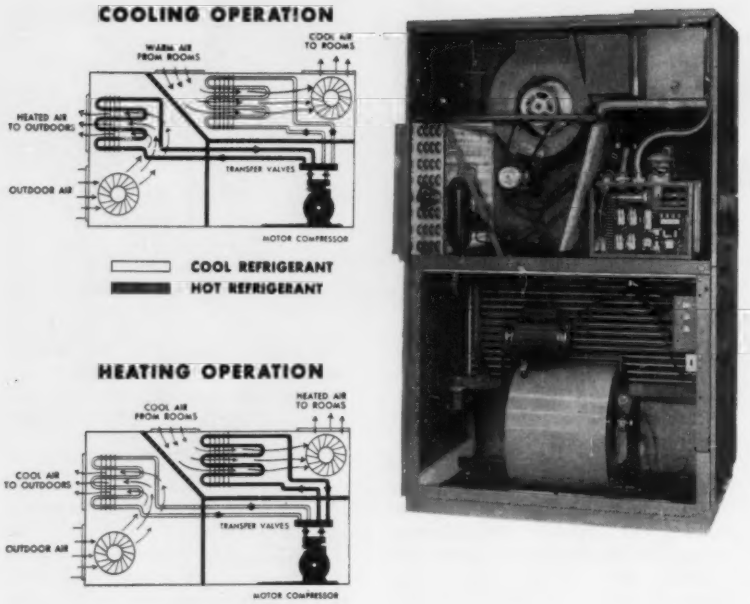
* Estimated

TABLE V. Sources of energy for generation of electricity in U. S. electric utility power plants

Year	Percentage from: Fuel	Percentage from: Hydro
1922	61.2	38.8
1927	62.2	37.8
1932	58.6	41.4
1937	63.0	37.0
1942	65.6	34.4
1947	69.3	30.7
1954	77.3	22.7

TABLE VI. Estimated world reserves of fuel energy

Fuel	Energy, Btu
Fossil fuels:	
Petroleum	Less than 8×10^{18}
Natural gas	Less than 1×10^{18}
Coal	72×10^{18}
Total fossil fuels	81×10^{18}
Fission fuels (1 to 1 breeding)	1770×10^{18}
Ratio of fission fuels to fossil fuels, 22:1	



The heat pump, General Electric's Weathertron (seen in photo with front panels removed), can heat or cool living spaces automatically. How it works for heating and cooling operations is shown in diagrams.

will the goal be attained? Ten years may be too soon. But we should be close to it by 1966. Some consequences of the advent of the atomic power plant, to the civil engineer, will be:

1. There will be no fuel transportation problem, since uranium and thorium are "weightless" fuels.

2. The problem of securing water for condensing service will be magnified because of the poor heat rates which accompany the use of low steam pressures and temperatures, as at present planned for atomic plants.

3. In meeting containment requirements to reduce the damage from an accident to the pile, there will be structural problems—to be solved by spheres, cylinders, and underground construction.

4. Disposal of wastes and spent fuels will pose problems under conditions which dwarf the present ones of disposal of refuse from coal-burning powerhouses. Encasement of atomic wastes in concrete and burial in the ocean will not necessarily be the solution, considering the long periods of radioactivity involved and the difficulty of transporting such contaminated wastes.

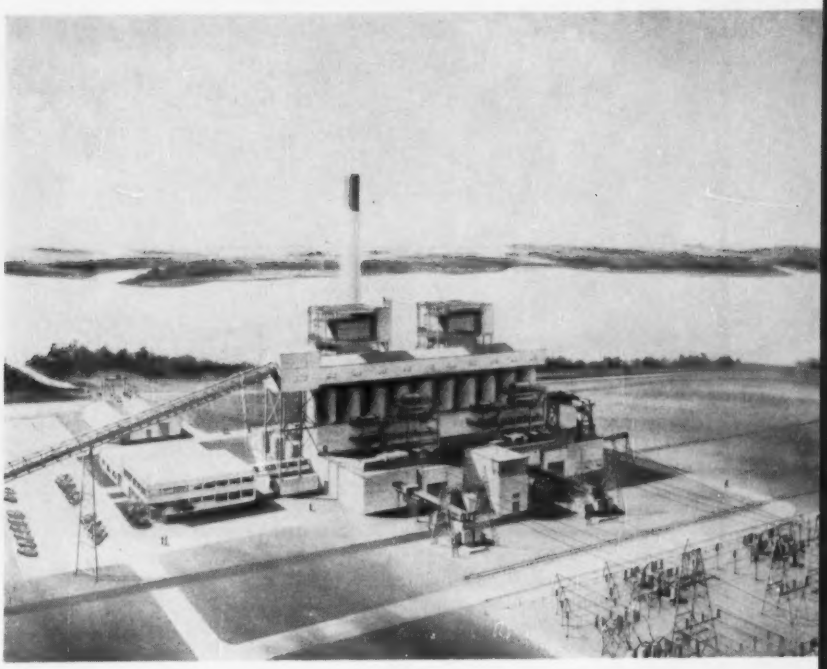
Power takes water

The water problem is one that is certain to be of great interest to the civil engineer. While the hydroelectric plant may become of decreasing importance in the future, it must be recognized that large thermal power plants, fired by either fossil or nuclear fuels, will be faced with problems of light or variable-load operation. In regions with a hilly terrain it is believed that pumped storage may find favor. This would be economically attractive if the structures could be built at a low enough cost. High-head sites (500 or 1,000 ft) would make for small tail and head reservoirs, and for pipelines and tunnels of small diameter. Watersheds in which the runoff is small could be utilized where only enough make-up water would be needed to compensate for evaporation and seepage losses. The idea of pumped storage is not new but its economy can be much better than formerly. Not the least of the economic factors involved is the fact that pumps can be built today with efficiencies substantially equal to those obtainable in hydraulic turbines.

The demand for water will increasingly tax the ingenuity of the engineering profession. Water is probably our most valuable resource. Those of us who live in the East often do not realize the blessing we have in our water supply. In Texas and many other parts of the country, the level of the water table is dropping at an alarming rate. In the Southwest, for example, the inadequacy of the water supply is obvious, as witness the current litigation over the remaining flow in the Colorado River. The selection of a site for a new condensing steam plant grows steadily more difficult, as witness the recent opposition of one community after another in Connecticut to the location of a new powerhouse in its area. Many areas have been compelled to use reclamation systems with towers and ponds to conserve water resources.

In most communities the restrictive regulations on the use of water grow steadily more severe. The trend toward land reclamation will grow—not decrease. And with this trend stream pollution, like atmospheric pollution, will no longer be tolerated no matter how exigent or righteous the need. Stream pollution should not be limited to a definition based upon chemistry or suspended solids. It means temperature rise as well. In some regions the need to reclaim water from sewage can become very real in the future. The ingenuity of the civil engineer will be taxed to devise reliable, economic means of supplying water to industry and to homes.

Some voluble politicians and society columnists have pictured the automobile of the future as having a pellet of nuclear fuel built in at the factory so that no gasoline or diesel fuel supply will be needed subsequently. This is hard to visualize when the problems of the critical mass, the necessary shielding, the investment required, and the insurance against highway accidents are considered. There will be very few, if any, nuclear automobiles—or locomotives—in the next ten years. Liquid fuel—gasoline or distillate—will con-



Trend toward outdoor-type steam-electric stations is exemplified by Montrose Station now under construction for Kansas City Power & Light Company. Turbines, generators, and boilers are exposed to the weather. Cylindrical coal bunkers are over firing aisle. Artificial lake of 11,000-acre-ft capacity furnishes cooling water for this plant, which was designed by Ebasco Services, Inc., New York.

tinue to dominate the land propulsion plant.

For seagoing, naval, and aircraft applications, the picture can be very different. The sheer bulk of the liquid fuel required, with the ever-increasing demands for more speed, and therefore more power, can be offset by turning to the weightless nuclear fuels. The economics of pay load may retard development in the commercial field, but the enhanced military effectiveness should result in a Navy that is essentially nuclear propelled by 1966.

There are sanguine hopes in some quarters for the gas turbine and its application to automotive service. The many inducements include high-speed machinery, low weight, low bulk, high starting torque, the burning of lower-cost distillate, good thermal efficiency, fewer machine parts, no freezing problem, and minimum consumption of lubricant. These are all potent inducements for the perfection of an automotive gas-turbine. But the very low cost of the reciprocating automobile engine, as it comes from the Detroit production lines, is a serious obstacle. Similarly, the problem of a low-priced mechanism for control of the gas-turbine has not been solved. The price of the gas-turbine and that of its control are two current impediments. Research and development alone can find the answers and demonstrate whether there will be a competitive automotive gas-turbine plant in ten years.

Impact of cheap electricity

When the stationary nuclear power plant realizes the low cost and reliability that seem to be inherent in it, electric energy will find a market and uses that will be little short of revolutionary. Nuclear locomotives may not be realistic but electrified railways could return to economic favor using the output of stationary nuclear power plants as a source of electric energy supplied to the locomotives. Whether the development of nuclear power plants will move fast enough for this to be an actuality by 1966 is open to debate.

Should the cost of nuclear fuel become small, if not zero, the resulting changes in our industrial economy would be far-reaching. The operational and economic problems of the power plant would be similar to those of hydroelectric plants, especially the base-load type. This could serve as a tremendous impetus toward the perfection of large-capacity electric storage batteries or toward the perfection of radiation chemistry techniques, either to develop electric automobiles or to synthetize liquid fuels for motor cars. While such things probably will not happen within the next decade, the ultimate impact should be there.

It is thus possible to speculate on possible changes in railway and automotive power practices. For the civil engineer it should be evident that there will be ample supplies of energy to run the land vehicles of the future. The recently enacted federal highway legislation requires construction of projected highways that will require large supplies of building materials—cement, concrete, cinders, aggregates. The coal-burning steam power plants, which have been compelled to use lower grades of fuel over the years, are making more and more refuse which should find use in the civil engineers' store of raw materials.

The disposal of ash by direct utilization, by sintering, or by pelletizing is rapidly moving out of the laboratory stage. Ash can be expected to become a competitive building material with which construction people must reckon. Fly ash from plants using pulverized coal will not be discharged to the atmosphere as a pollutant, but will be collected and put to good use. There may be a variety of ways in which fly ash can be used but the most likely is probably as an aggregate for concrete. This use will require careful study of how to utilize the ash and still obtain the desired structural properties and strength in the finished product. This development has already reached such a stage that many people are wondering whether the supply of fly ash will be adequate for the expected market.

Growth of air-conditioning

Another way in which the supply of ample, cheap electric energy will change the civil engineer's outlook is in the year-round heating and cooling of living space. Not too long ago many

Boiler fly ash can be transformed into light-weight aggregate, as shown in demonstration at Agglomeration Laboratory of Koppers Co., Inc., in Pittsburgh, Pa. Here cake, made up of $^{3}/_{8}$-in. pellets loosely bonded, issues from laboratory sintering machine. Full-scale machine produces cake 7 ft wide and 8 in. thick.

houses were not equipped with central heating. Practicing engineers will recall that even in the city of New York, the cold-water flat is not yet extinct. Most people today demand central heating during the winter, and many have reached the stage where they will not tolerate oppressively high temperature or high humidity in summer. The demand for summer cooling is evidenced by the sale of over a million air-conditioning units each year for some time past.

Thus the civil engineer is confronted by the demand that space be conditioned for comfort during twelve months of the year and not just during the period from October to April. New building designs must incorporate year-round air conditioning. But the problem of the older building still remains. Such structures as the Empire State Building or the Waldorf-Astoria Hotel will not be demolished just because they lack year-round air-conditioning. In the next ten years the civil engineer will be called upon to alter such buildings, for a reasonable price, so that they will be equally habitable in summer and winter—so that they will be able to compete, on a dollar basis, with the most modern new buildings. This is a large order and it will be difficult to sell when the price tag is included.

It is reasonable to expect that the power industry will make a large contribution to the air-conditioning art. If summer cooling and winter heating are accepted as equally necessary for building space, then an abundant supply of low-priced electric energy could be the key to the solution of the problem. If the same equipment can be used for both heating and cooling, then the economic picture becomes brighter. This is the advantage of the electrically driven heat-pump. Its operation can be reversed so that it can perform throughout the year. Being electrically operated, it can be placed anywhere in the building structure. Excavations for basements are not necessary. Chimneys become obsolete—and on a tall building the chimney can be a serious problem in itself. Fuel storage tanks or fuel piles are no longer required. The ash disposal problem, the smoke nuisance, and the operating labor force dwindle or disappear when the heat-pump enters the picture.

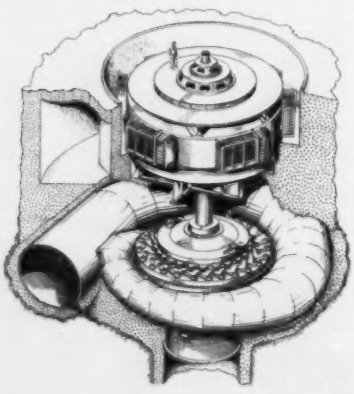
In the next ten years the electrically driven heat-pump is bound to have a pronounced impact on civil engineers interested in the building trades. It should prove to be more economical, as well as more convenient, to transport energy electrically than to rely on central steam-heating or hot-water systems. The natural-gas pipeline will be competitive for some time but the truck delivering oil should tend to join the coal wagon in becoming obsolete.

The public will demand the convenience of a completely electrified economy, and the power engineer will be able to provide the energy at a price that will be attractive. In supplying this electric energy, the civil engineer will have to contribute his talents so as to make it possible to handle the maximum amount of energy over a given electrical transmission right-of-way. Rights-of-way are steadily growing scarcer and more expensive. This will pose a challenge to the civil engineer to design the most suitable structures on each right-of-way. It is difficult to see how underground construction, despite its esthetic appeal, can replace the overhead type. It is not unusual for subterranean construction to cost ten times as much as an overhead transmission and distribution system.

I have outlined a few of the ways in which the power engineer is going to help alter our industrial economy. All of them constitute a very definite challenge to the civil engineer. The civil engineer will be called upon to do things that heretofore have been considered uneconomical, if not unrealistic, because the power engineer is going to offer energy for stationary and transportation services at prices that simply cannot be ignored.

(This article is based on the paper presented by Professor Baumeister at the Conference of Metropolitan Student Chapters of ASCE, November 3, 1956.)

Gigantic reversible pump-turbine made by Allis-Chalmers was recently installed at TVA's Hiwassee Dam. When operated as a turbine (rated at 120,000 hp), it can drive 70,000-kva generator for peak power needs. When operated as a pump (driven by 102,000-hp motor using off-peak power), it will lift 3,900 cfs 205 ft back into Hiwassee Reservoir for reuse.



Computing the properties of composite sections of highway bridges

ANGEL VILLASOR, Jr., J.M. ASCE

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The designer of highway bridges is inevitably confronted with the tedious determination of the properties of composite sections. To facilitate these calculations, the following method of tabular computation is proposed.

Theory explained

Noting that $n = \frac{E_s}{E_c}$, the following equations become obvious from Fig. 1:

$$A_{cs} = A_s + \frac{1}{n} A_c \quad \ldots \quad (1)$$

$$Y_{cs} A_s = Y_c A_{cs} \quad \ldots \quad (2)$$

$$= Y_c A_s + \frac{1}{n} Y_c A_c$$

$$(Y_{cs} - Y_c) A_s = \frac{1}{n} Y_c A_c$$

$$Y_s A_s = \frac{1}{n} Y_c A_c \quad \ldots \quad (3)$$

$$I_{cs} = I_s + A_s Y_s^2 + \frac{1}{n} I_c + \frac{1}{n} A_c Y_c^2 \quad (4)$$

$$= I_s + \frac{1}{n} I_c + A_s Y_s^2 + Y_c Y_s A_s$$

$$= I_s + \frac{1}{n} I_c + Y_{cs} Y_s A_s \quad \ldots \quad (5)$$

Let $K = Y_{cs} A_s \quad \ldots \quad (6)$

Then $Y_s = \frac{K}{A_{cs}} \quad \ldots \quad (7)$

Put $I_o = K\, Y_s \quad \ldots \quad (8)$

$$I_{cs} = I_s + \frac{1}{n} I_c + I_o \quad \ldots \quad (9)$$

Procedure outlined

1. Record A_s and $\frac{1}{n} A_c$ and get A_{cs} (Eq. 1).
2. Record I_s and $\frac{1}{n} I_c$
3. Record Y_{cs} and then compute the constant K (Eq. 6).
4. Obtain the values of Y_c and Y_s.
5. Compute I_o and then I_{cs} (Eqs. 8 and 9).
6. Finally, determine the section modulus, S.

In practice, it is best to tabulate the data obtained and for convenience to include in the table a column for Q, the statical moment of the slab. Built-up steel girders call for a separate calculation for I_s. This represents about the only part of the computation that is relatively involved. For wide-flange sections having cover plates, this preliminary work is reduced, but the values of I_s can be taken directly from steel handbooks when the plates are eliminated. If a concrete haunch is provided in the section, its influence may approximately be taken into account by adjusting only A_c and Y_{cs}.

Example presented

The method is presented for an interior beam section with a roadway concrete slab having $b = 60$ in. and $t = 5$ in. on a 36WF150 with a cover plate of $10 \times {}^3/_4$. The resulting computations are shown in the box, Table I.

The advantage of this method lies in the fact that the effect of varying n in the computations is replaced by a constant, K. Consequently, the tabulation lends itself easily to single settings for column computation and, as a whole, results in a neat reference record. Because of its simplicity, the method can be made a routine design procedure in no time at all.

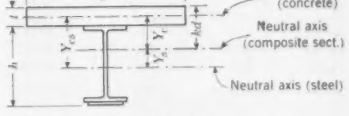
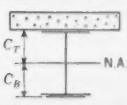


FIG. 1.

TABLE I. Computations for example



36WF150: $A = 44.16$
Pl. $10 \times {}^3/_4$: $= 7.50$
Slab: $A_s = 51.66$
$A_c = 60 \times 5 = 300$

$$C_T = \frac{44.16 \times 17.92 + 7.5 \times 36.215}{51.66} = 20.58$$
$$I_s = 9012.1 + (44.16 \times 2.66^2) + (7.5 \times 15.64^2) = 11,159.6$$
$$I_c = \frac{1}{12} 60 \times 5^3 = 625$$
$$K = 51.66 \times 23.08 = 1192.3128$$

n	A_s	$\frac{A_c}{n}$	A_{cs}	I_s	$\frac{I_c}{n}$	Y_{cs}	Y_c	Y_s	I_o	I_{cs}	kd	$\frac{C_T}{C_B}$	$\frac{S_T}{S_B}$	Q
∞	51.66	0	51.66	11,159.6	0	23.08		0	0	11,159.6		20.58	542.3	. . .
												16.01	697.0	. . .
30		10.00	61.66		20.8		19.34	3.74	4,459.2	15,639.6	21.84	16.84	928.7	193.4
												19.75	791.9	. . .
10		30.00	81.66		62.5		14.60	8.48	10,110.8	21,332.9	17.10	12.10	1,763.0	438.0
												24.49	871.1	. . .
8		37.50	89.16		78.1		13.37	9.71	11,577.4	22,815.1				

Note: All dimensions are in powers of inches.

Beam moment of inertia determined by table

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Consulting Engineer, Reno, Nev.

TABLE I. Beam deflections

STEEL, $E = 30 \times 10^6$ psi TIMBER, $E = 1.6 \times 10^6$ psi

			Required I/w		Required I/w	
	$\frac{l}{360}$	$\frac{l}{240}$	For $\frac{l}{360}$	For $\frac{l}{240}$	For $\frac{l}{360}$	For $\frac{l}{240}$
2′-0	0.067	0.100	0.000179	0.000120	0.00335	0.00225
2′-6	0.083	0.125	0.000353	0.000235	0.00660	0.00440
3′-0	0.100	0.150	0.000608	0.000406	0.0114	0.0076
3′-6	0.1167	0.175	0.000963	0.000643	0.0181	0.0121
4′-0	0.1333	0.200	0.00144	0.000956	0.0270	0.0179
4′-6	0.150	0.225	0.00205	0.00137	0.0384	0.0256
5′-0	0.1667	0.250	0.00281	0.00188	0.0527	0.0351
5′-6	0.1835	0.275	0.00374	0.00249	0.0702	0.0468
6′-0	0.200	0.300	0.00487	0.00324	0.0912	0.0608
6′-6	0.2165	0.325	0.00619	0.00413	0.1160	0.0772
7′-0	0.2335	0.350	0.00773	0.00516	0.1448	0.0964
7′-6	0.250	0.375	0.00952	0.00635	0.1780	0.1185
8′-0	0.2665	0.400	0.01155	0.00769	0.2170	0.1445
8′-6	0.2835	0.425	0.01385	0.00922	0.2590	0.1727
9′-0	0.300	0.450	0.0164	0.01095	0.3070	0.2050
9′-6	0.3165	0.475	0.0193	0.01285	0.3610	0.2410
10′-0	0.3333	0.500	0.0225	0.0150	0.4220	0.2810
10′-6	0.350	0.525	0.0261	0.0174	0.4890	0.3255
11′-0	0.3663	0.550	0.02995	0.0200	0.5620	0.3745
11′-6	0.3836	0.575	0.0343	0.0229	0.6420	0.4285
12′-0	0.400	0.600	0.0389	0.0260	0.7280	0.4850
12′-6	0.4163	0.625	0.0439	0.0293	0.8230	0.5490
13′-0	0.433	0.650	0.0495	0.03295	0.9270	0.6180
13′-6	0.450	0.675	0.0553	0.0368	1.038	0.6920
14′-0	0.466	0.700	0.0618	0.0412	1.160	0.7720
14′-6	0.483	0.725	0.0688	0.0450	1.285	0.8550
15′-0	0.500	0.750	0.0758	0.0506	1.423	0.9480
15′-6	0.517	0.775	0.0838	0.0558	1.570	1.048
16′-0	0.533	0.800	0.0920	0.0614	1.726	1.152
16′-6	0.550	0.825	0.1011	0.0673	1.893	1.262
17′-0	0.566	0.850	0.1110	0.0740	2.080	1.385
17′-6	0.583	0.875	0.1205	0.0805	2.260	1.507
18′-0	0.600	0.900	0.1310	0.0873	2.455	1.638
18′-6	0.616	0.925	0.1425	0.0950	2.675	1.781
19′-0	0.633	0.950	0.1543	0.1028	2.892	1.929
19′-6	0.650	0.975	0.1667	0.1113	3.125	2.085
20′-0	0.667	1.00	0.1795	0.1197	3.365	2.245
20′-6	0.683	1.025	0.1938	0.1292	3.635	2.420
21′-0	0.700	1.050	0.2085	0.1390	3.900	2.600
21′-6	0.717	1.075	0.2235	0.1490	4.185	2.800
22′-0	0.733	1.100	0.2400	0.1600	4.495	2.990
22′-6	0.750	1.125	0.2560	0.1705	4.785	3.190
23′-0	0.766	1.150	0.2740	0.1828	5.130	3.425
23′-6	0.783	1.175	0.2920	0.1945	5.470	3.650
24′-0	0.800	1.200	0.3115	0.2075	5.830	3.890
24′-6	0.816	1.225	0.3310	0.2208	6.200	4.130
25′-0	0.833	1.250	0.3518	0.2345	6.580	4.390
25′-6	0.850	1.275	0.3730	0.2485	6.990	4.660
26′-0	0.866	1.300	0.3955	0.2640	7.405	4.935
26′-6	0.883	1.325	0.4185	0.2790	7.840	5.230
27′-0	0.900	1.350	0.4430	0.2955	8.300	5.530
27′-6	0.916	1.375	0.4680	0.3120	8.770	5.850
28′-0	0.933	1.400	0.4930	0.3290	9.240	6.160
28′-6	0.950	1.425	0.5210	0.3475	9.760	6.510
29′-0	0.966	1.450	0.5490	0.3660	10.30	6.850
29′-6	0.983	1.475	0.5780	0.3855	10.84	7.225
30′-0	1.00	1.500	0.6070	0.4050	11.39	7.590
30′-6	1.016	1.525	0.6390	0.4260	11.97	7.975
31′-0	1.033	1.550	0.6690	0.4460	12.55	8.360
31′-6	1.050	1.575	0.7030	0.4680	13.17	8.780
32′-0	1.066	1.600	0.7380	0.4920	13.84	9.230
32′-6	1.083	1.625	0.7720	0.5150	14.45	9.650
33′-0	1.100	1.650	0.8080	0.5390	15.15	10.10
33′-6	1.116	1.675	0.8460	0.5650	15.87	10.59
34′-0	1.133	1.700	0.8840	0.5900	16.59	11.07
34′-6	1.150	1.725	0.9240	0.6160	17.35	11.58
35′-0	1.166	1.750	0.9660	0.6450	18.12	12.10
35′-6	1.183	1.775	1.005	0.6700	18.85	12.57
36′-0	1.200	1.800	1.050	0.7000	19.69	13.13
36′-6	1.216	1.825	1.093	0.7310	20.58	13.70
37′-0	1.233	1.850	1.140	0.7600	21.35	14.25
37′-6	1.250	1.875	1.185	0.7900	22.15	14.83
38′-0	1.266	1.900	1.236	0.8230	23.20	15.46
38′-6	1.283	1.925	1.285	0.8560	24.08	16.08
39′-0	1.300	1.950	1.337	0.8920	25.10	16.73
39′-6	1.316	1.975	1.387	0.9250	26.00	17.30
40′-0	1.333	2.000	1.445	0.9620	27.00	18.00

Day-to-day work of a structural designer involves the design and selection of numerous uniformly loaded simple beams. In many of these, particularly in building design, the deflection must be limited because of the danger of cracking in plastered ceilings or other undesirable conditions. With the uniform load as a known or assumed quantity, the designer will frequently solve for the section modulus required so that the allowable unit stress will not be exceeded, and then will solve for the required moment of inertia so as not to exceed a deflection which is a certain proportion of the span.

It is common practice under certain conditions to limit the deflection to 1/360 or 1/240 of the span length, l. Theoretically this is a simple process, for the maximum deflection of a simple beam uniformly loaded is $5wl^4/384EI$ and the required I is $5wl^4/384Ed$. However, in practice there are quite a number of slide-rule operations in the solution of this equation for I.

For a given span and a given material the only unknown factors in this equation are the load w, and the deflection d. With the allowable deflection as a function of the span, the only unknown becomes the load w, for a given span and material. Therefore a table can be set up with functions of the span, the material and its modulus of elasticity, and the allowable deflection as a function of the span as shown in the accompanying table. With the selection of the proper constant from the table and the known or assumed uniform load w, the required section modulus can be determined with two slide-rule operations.

Example solved

Given: Simply supported steel floor beam of 17-ft 6-in. span, laterally supported by wood floor joists. Uniform load on beam is 1,350 lb per ft. The deflection is to be limited to $l/360$ because of the presence of a plastered ceiling below the beam.

$$M = \frac{17.5^2 \times 1{,}350}{8} = 51{,}700 \text{ ft-lb}$$

$$\text{Required } S = \frac{12 \times 51{,}700}{20{,}000} = 31.1 \text{ in.}^3$$

$$\frac{l}{360} = 12 \times \frac{17.5}{360} = 0.583 \text{ in.}$$

By formula, required $I = \dfrac{5wl^4}{384Ed}$

$$= \frac{5 \times 1{,}350\,(12 \times 17.5)^4}{12 \times 384 \times 30{,}000{,}000 \times 0.583}$$

$= 163$ in.^{4}

or, by Table I, the required $I =$

$0.1205 \times 1{,}350 = 163$ in.^{4}

A 12 WF 27 beam is selected.

Perhaps such a table has been previously published by others or is in current use in some design offices, although I have been unable to find any record of it. The value of the table is evidenced by the fact that the time saved by its use in a three-month period by my staff was adequate to compensate for the time spent in its preparation.

Credit must be given to Wallace J. Rabenstine, J. M. ASCE, of my staff for the actual preparation of the accompanying table.

THE READERS WRITE

Truss-tied arch bridge has a long history

TO THE EDITOR: The truss-tied arch, a shallow truss stiffened by an arch, was originated by the Austrian engineer Joseph Langer in 1859. This system is eminently suitable for double-deck construction. The 750-ft span Fort Pitt Bridge, described by Charles R. Way in the October issue, p. 39, will probably be the longest and the first double-deck structure of this type—but by no means the first truss-tied arch bridge to be built.

Photographs and data on more than 100 girder-tied arch bridges have been published; the longest span, 838 ft, was built in 1950. Some of them are at the following locations: Mur River, Graz, 1881; Ihme River, Hannover, 1889; Kufürstendam Street, Berlin-Hallensee, 1892; Elbe-Trave Canal, 1898; Segeroth Street, Essen, 3 spans, 1910; Kleinfeld Street, Mannheim, 2-span continuous, pedestrian, 1920; Spree River, Wiederdammer, Berlin, 1924; Danube River, Györ, first with side spans, 1925; Traun River, Ebelsberg, 1928; Oder River, Glogau, two single-track railroad spans side by side, 1928; Elbe River, Tetschen-Bodenbach, with side spans, 1930; Drava River, Maribor, with side spans, 1933; Oder River, Schwetig, double-track railroad, 1938; Zala River, Zalahidveg, 1948.

Truss-tied arch spans of 896 and 912 ft were proposed for the double-track railroad Rhine River Bridge, Ludwigshafen, 1929. A double-deck structure, of 1,400-ft span with 510-ft side spans, was investigated for the East Bay Crossing of the San Francisco–Oakland Bay Bridge in 1934. A double-deck bridge over the Rhine River, 2,460 ft long, with a 985-ft span and two and three 295-ft side spans, was proposed in 1938.

Because of the extensive construction of this type of structure, its theory has been developed quite thoroughly. Computations with 18 unknowns were published in 1936. Analysis of the effects of the deformations on the stresses in the structure, by the deflection theory, was published by F. Stüssi in 1936 and in 1940. Hanger influence lines were discussed by J. Wanke in 1922 and very extensively by Victor Haviar in 1948.

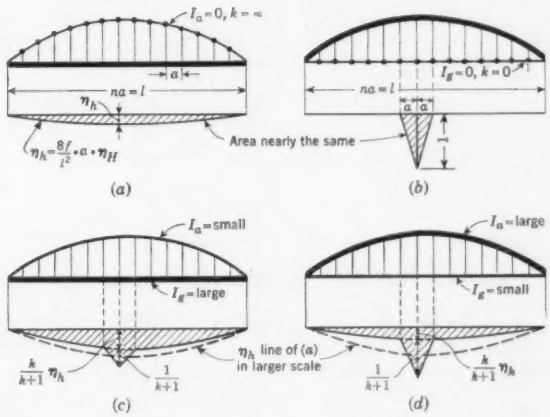
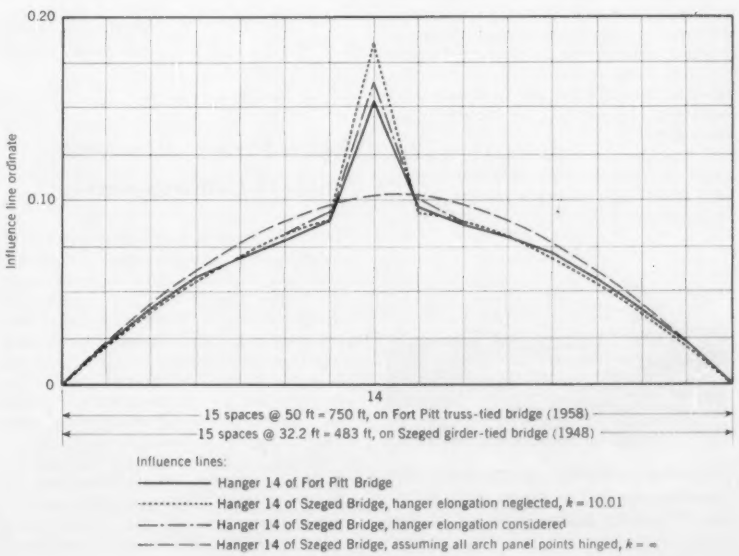


FIG. 1

FIG. 2



Extreme conditions, and the corresponding hanger influence lines, are indicated in Fig. 1(*a*) and (*b*). The practical cases are shown in (*c*) and (*d*). The area of the hanger stress influence line diagrams in Fig. 1(*a*) to (*d*) is nearly the same. The hanger influence line is similar to the *H* line,

$$\eta_h = \frac{8f}{l^2} \cdot a \cdot \eta_H$$

$$k = \frac{I_g}{I_s \cos \varphi}$$

Neglecting hanger elongation and assuming that k is a constant in the vicinity of the hanger in question, the hanger stress influence line becomes:

$$\eta_s = \frac{k}{k+1} \eta_h + \frac{1}{k+1}$$

The hanger elongation is:

$$\epsilon_h = \frac{y}{EA} \cdot \frac{k}{k+1} + \frac{y}{EA} \cdot \frac{1}{k+1}$$

The effect of the first term is zero; the effect of the second term is felt only in that it diminishes the ordinate at the hanger in question, usually about 10 percent. At the panel points right and left, the ordinates increase so that no change occurs in the total area of the influence diagram. The change at all other panel points is very small. If the bridge carries only a uniform load, any of the hanger influence lines is satisfactory for design. This is not the case when a heavy concentrated load has to be considered.

The comparative hanger influence lines of the Fort Pitt Bridge and the Tisza River Bridge at Szeged are shown in Fig. 2. The computed influence lines of the latter bridge were in very satisfactory agreement with the values measured on the model of the Fort Pitt Bridge.

The Fort Pitt Bridge will be opened to traffic on the one-hundredth anniversary of the development of the truss-tied arch, a fitting tribute to Josef Langer, who originated also the self-anchored suspension bridge.

LOUIS BALOG
Consulting Engineer
Binghamton, N. Y.

Projected Fort Pitt Bridge similar to Iceland structure

TO THE EDITOR: I have just seen the October issue and read with interest, in the article by Charles R. Way, A.M. ASCE, the description of the proposed Fort Pitt Bridge of 750-ft span on the Penn-Lincoln Parkway at Pittsburgh, Pa. This bridge is referred to in the text, and again in a picture caption, as "the only known arch tied by a truss."

It may be of interest to note that there is at least one other bridge of this type in existence. This is the Pjorsa Bridge in Iceland, constructed in 1950 by Messrs. Dorman Long & Co., Ltd., of Middlesbrough, England, for the Government of Iceland. It is shown in the accompanying photograph.

I was also much interested in the diagram of the calculated influence line for load in a hanger, showing an abrupt peak in the curve in the vicinity of the hanger for which the influence line is drawn. I have analyzed another stiffened tied arch, having in this case 12 hangers and a plate girder tie, and when secondary bending moments in the arch rib and hangers were taken into account, I obtained influence lines for hanger loads of this same surprising shape.

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Pjorsa Bridge, Iceland, constructed in 1950, has steel arch tied by a truss, similar to design of Fort Pitt Bridge projected for Pittsburgh, Pa.

Related sciences contribute much to civil engineering

TO THE EDITOR: Mr. Milton Alpern's article on intercommunication and the application of ideas in civil engineering, in the August issue (p. 60), is interesting and worthy of study. Civil engineering is a very broad field and can benefit from findings in many seemingly unrelated sciences. I became interested in this problem nearly two decades ago, and have written articles on various phases of it for engineering publications in India and Great Britain.

Striking instances are seen in the applications of aerodynamics to long-span suspension bridges, to the streamlining of automobiles and rolling stock, to the use of wind-tunnel tests for evaluating wind pressure on buildings and bridges, to the orientation of airports, and to the design of thin-walled sections and stressed-skin-type structures analogous to aircraft frames.

Meteorology also offers a fertile field for exploration because of the civil engineer's interest in gusts, in wind and snow loads, in rainfall and runoff, as well as in microclimatology for building and town planning.

The importance of photography is now realized not only in photogrammetric surveying and aerial mapping but also in photoelastic stress analysis of complex members and machine parts. Statistical techniques are being applied to the evaluation of safety factors in structures. The nuclear irradiation technique is being used to step up the strength and elasticity of structural materials such as concrete, timber, and aluminum, and to permit the use of unreinforced concrete for carrying high stresses.

In this age the civil engineer cannot keep up to date without acquiring some knowledge of related branches of engineering which a few decades ago were considered to have no relation to his profession. A broad liberal education, coupled with the correct type of reading, is necessary to acquire such knowledge. The mode of dissemination of technical information is ably dealt with by Dr. J. E. Holmstrom in *Records and Research in Engineering and Industrial Science*, Chapman & Hall, London, 1947.

S. K. GHASWALA, A.M. ASCE
Chartered Engineer
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Intercommunication among engineers

TO THE EDITOR: My article on "Intercommunication and the Application of Ideas—Are These Being Engineered?" in the August issue (p. 60), drew some thoughtful and interesting comments, most of which were addressed to me personally. I thank the writers for their efforts. It would be inconsistent with proper communication if these comments were buried in my files. Rather, I would share them with the profession.

Every writer agreed that a considerable problem exists and that too little is being done about it. In addition, some important suggestions for action were advanced:

1. J. A. C. Bowen, of The Hydro-Electric Power Commission of Canada wrote, "There would be an advantage in the establishment of an experimental and development organization. This organization could be established by industry, by government or by a combination of both."

2. Mr. Savage, Consultant, Professional Relations, Engineering Personnel Service of General Electric, sent the article to John Horn, Consultant, Technical

(*Continued on page 110*)

. . . . . *Am-Soc Briefs*

To what extent can retired engineers help fill the manpower shortage? That is a question being studied now by the Engineering Societies Personnel Service. (For details see the item by Secretary Emeritus W. N. Carey on page 77.) There is a wealth of engineering experience in this segment of the engineering population ..... The big question, are enough men in this category interested in slipping on the harness again?

In recent weeks every member of ASCE received a copy of the new-style Annual Report. Its primary purpose is to inform members of the actions and activities of their Society during the preceding twelve months. Everyone should take the time to read this report through. The strength of the Society depends on the active interest and participation of its members.

Prompted by the success of its Knoxville program, the Structural Division is again planning a conference-type program. All of the fourteen papers at the Division's Jackson session will be devoted to the design of highway bridges. As a matter of fact, almost all the Divisions are participating in the 35-session Jackson Convention (see page 72).

Qualified to transfer from Associate Member to Member? There is a short form available requiring only three references and no signatures. And only that experience gained since applying for Associate Member need be listed. (See page 78 for story.)

Some sort of a record was achieved when the Los Angeles Section, along with its Desert Area Branch, hosted a 1,200-man field trip to the Naval Ordnance Test Station at China Lake. If there had been room, over 2,300 would have gone. Among the highspots of the trip was an actual rocket-propelled test run at a speed exceeding 1,100 mph..... Public relations is not a sometime thing with the Philadelphia Section. For an interesting report on their well-rounded program see the article by Section President V. G. Thomassen page 82.....The Illinois Section celebrated an anniversary, its fortieth, with a celebration banquet underscoring its contribution to the City of Chicago. Helping to blow out the candles was Chicago's Mayor Daley who spoke on the "Chicago of the Future."

SOCIETY NEWS

MERRY CHRISTMAS  HAPPY NEW YEAR

Impressive Technical Program Slated for Jackson Convention

In Jackson, Miss., host to the Society's Spring Convention, General Chairman Sydney W. Chandler and his staff of Mid-South Section members are busy arranging an unusual technical program and a full schedule of social events, entertainment, and excursions. In the November "Society News" Jackson was discussed as the ideal Convention and winter vacation city, both location and climate wise. Here we will mention some of the outstanding Technical Division sessions on the agenda. The full program will appear in January.

Over 100 papers are being prepared for presentation in about 35 technical sessions. Almost all the Technical Divisions will be represented by one or more sessions, insuring a program of sufficient scope to hold something of interest for everyone.

This Jackson Branch group assembles for further Convention planning. Seated, left to right, are Ben T. Collier, Steering Committee and director of Mid-South Section; Mrs. Sydney W. Chandler, chairman, Ladies Committee; Sydney W. Chandler, general chairman; Boyce H. Biggers, chairman, Hotel Committee; Arthur C. Miller, chairman, Reception Committee and vice-president, Jackson Branch; and Horace B. Lester, president Jackson Branch, and member, Reception Committee. Standing, in same order, are John E. Hall, Hotel Committee; Karl A. Dupes, past-president, Jackson Branch and member, Hotel Committee; Silas S. Scott, director, Jackson Branch and member, Transportation Committee; James H. Polatty, Registration Committee; Henry C. McGee, chairman, Registration Committee; Irving E. Anderson, vice-chairman, Program Committee; James E. Foster, chairman, Transportation Committee; and Charles S. Hill, chairman, Publicity Committee.

First Pipeline Division Program

The newly formed Pipeline Division is scheduling its first Convention program, which will include two technical sessions and a field trip. Among the papers are: "Prediction of Surge Pressures in Oil Pipelines," R. D. Kersten, Carter Oil Co., Tulsa, Okla.; "Fundamental Fluid Mechanics for Oil Pipelines," F. E. Hangs, Pipeline Technologists, Inc., Houston; "Flow of Natural Gas in Pipelines," by W. T. Ivey, Southern Natural Gas Co., Birmingham, Ala.; "Advancements in Steel for Pipeline," by George McClure, Battelle Memorial Institute, Columbus, Ohio; "Hydrostatic Testing of Pipelines," by Leon Brooks, Williams Pressure Service, Shreveport, La.; and "Pipeline River Crossings," by Leo M. Odom, Baton Rouge, La.

Northern Natural Gas Co. will present a soundmovie of construction of a pipeline bridge over the Missouri River. G. D. Hartley, of the Arabian American Oil Co., in Saudi Arabia, will speak on "Men, Materials and Equipment" at a dinner on the evening of February 19. A field trip to the site of the $1,250,000 Mississippi River crossing of the Mid-Valley Pipeline at Mayersville, Miss., has been arranged with R. D. Jackson, chief engineer of the Soho Pipe Line Co.

The Sanitary Division has planned sessions on education and administration in sanitary engineering, waste disposal, and water resources. The water resources session will feature papers by J. V. B. Wells and A. G. Fiedler, of the Water Resources Division of the U.S. Geological Survey, on surface-water and groundwater resources, respectively.

Contributions to the Waterways Divi-

sion program include: "Operation of Missouri River Main Stem Reservoirs," by R. J. Pafford, Jr., Missouri River Division, Corps of Engineers; "Development and Application of Improved Techniques and Equipment in the Telemetering of Hydrologic Data," by Francis P. Hanes, Waterways Experiment Station; and "Application of Differential Analyses and Digital Computers to Hydraulic Problems," by E. A. Lawler, of the Ohio River Division, and F. V. Druml, of the Louisville District, of the Corps of Engineers.

Important Highway Program

The attention focused on the national highway program adds to the importance of the program formulated by the Highway Division. There will be sessions on current problems relating to control of access, management and manpower problems in the expanded highway program, and a symposium on highway planning and finance, with Prof. Ralph A. Moyer, of the University of California, the presiding officer. In addition, there will be a session dealing with photogrammetric mapping held jointly with the Surveying and Mapping Division.

Papers of Regional Interest

Many papers will, of course, have particular application to the Mid-South. These papers have the added attraction that interested engineers can visit the projects discussed for first-hand observation. A notable group of papers falling into this category will be presented at one of the sessions of the Soil Mechanics and Foundations Division. These papers, written by engineers and geologists of the Waterways Experiment Station, deal with soils problems encountered in the construction of the lower Mississippi River control structures. The subjects are "Lower Mississippi Valley Geology," by C. R. Kolb and W. G. Shockley, "Underseepage and Its Control, Mississippi River Levees," by W. J. Turnbull and C. I. Mansur; and "Dewatering Excavation for Low Sill Structure, Old River, Louisiana," C. I. Mansur and R. I. Kaufman.

Diverse Inspection Trips

Tours that will permit members to visit many places of engineering interest in the area are on the agenda. One tour will take in the Rex Brown Steam-Electric Generating Station in Jackson. This 155,000-kw plant is unusual in that, due to the mild climate, no building is required to shelter the equipment. The itinerary also includes the Michael Baker, Jr., Engineering Offices in Jackson, where visitors will be able to observe modern photogrammetric equipment in use.

Two other tours will allow members to inspect the extensive research facilities of the Waterways Experiment Station. As a major research and investigational organization of the Corps of Engineers, the Waterways Experiment Station has gained international recognition for its work in the specialized fields of hydraulics, soil mechanics, and concrete. One of the tours will visit the Clinton reservation to observe the Mississippi River Basin model and the concrete research facilities. The other will cover the Vicksburg laboratories, where investigations dealing with soil mechanics, flexible pavements, and hydraulic problems are in progress.

Several of the Technical Divisions are featuring special luncheons at which there will be prominent speakers. The Waterways and Hydraulics Divisions will hold a joint luncheon meeting on Monday, February 18, with Maj. Gen. J. R. Hardin, president of the Mississippi River Commission, as the speaker. At the Convention Luncheon on Tuesday the members will hear an address by the Hon. James P. Coleman, governor of Mississippi. Wednesday noon will be devoted to the luncheons of the Soil Mechanics and Foundations and Structural Divisions.

The Entertainment Committee has organized a fine program of entertainment and social events. As a special feature, in traditionally "dry" Mississippi, a cocktail party is scheduled for Wednesday as part of the Convention Party. At this Convention Party, Dr. Walter Johnston of Vicksburg will give a humorous reading entitled, "The South Ain't Southern Any More." Other entertainment highlights include performances by the Jackson Symphony Orchestra.

For the ladies there will be a "brunch" followed by tea at the Governor's mansion on Tuesday; a day in Vicksburg touring famous points of interest, and of course, attendance with the men at the Convention Party.

Plan now to attend the Jackson Convention, and bring your wife.

One of interesting sights at Waterways Experiment Station, objective of two Jackson Convention tours, is jet blast test to determine if pavements can withstand jet blast and fuel spillage as well as high-pressure tire traffic. This view shows F-80 plane on flexible pavement test strip.

Model studies being conducted by Corps of Engineers at Waterways Experiment Station at Vicksburg include this set-up of Ohio River Locks and Dam No. 41 at Louisville, Ky. The model, built to a scale of 1 to 120, is approximately 40 ft wide and 200 ft long and represents about six miles of river. It is being used to study the most feasible and economical method of replacing old lock, canal, and dam with larger, more modern structures.

Structural Division Plans Highway Bridge Program for Jackson Convention

Success of its four-session technical-conference-type program on closely related subjects presented at the Knoxville Convention in June has prompted the Structural Division to plan a similar program for the coming Jackson Convention. All fourteen of its papers to be presented in four successive sessions, starting Tuesday, February 19, and ending Thursday, February 21, will be devoted to the design of highway bridges.

No more timely subject than bridges could have been chosen, considering the tens of thousands of new highway bridges to be constructed in the next 13 years in building the 41,000 miles of the "National System of Interstate and Defense Highways." Practically every mile of the Interstate System will be built on new right of way, which means designing and building bridges and drainage structures as well as the roadway itself.

According to the Federal Aid Highway Act of 1956, the entire Interstate and Defense System must be designed to "Standards. . . adequate to accommodate the types and volumes of traffic forecast for the year 1975." In order that the nation may derive the fullest benefit of the money expended, roadway and bridges must be designed and constructed to give service for at least 50 years beyond 1975 with a minimum expenditure for maintenance. Thus bridge engineers must give serious thought to proper application of recognized specifications for bridge design, to design loadings, factors of safety, vibrations, deflection limitations, and many other factors. The Structural Division program will afford an excellent opportunity to hear an unusually interesting group of papers on many apsects of highway bridge design and to participate in discussing them.

Appropriately E. L. Erickson, chief of the Bridge Branch of the Bureau of Public Roads, will lead off the opening session Tuesday with a discussion of "Applications of the AASHO Specifications to Highway Bridge Design." The origin and reason for many such provisions become obscured through the years, so designers will welcome an opportunity to hear an explanation and interpretation of particularly vital requirements of the specifications.

H. O. Ireland, research assistant professor of civil engineering, and R. B. Peck, research professor of soil mechanics at the University of Illinois, will follow with a joint paper on the subject, "Earth Pressures on Abutments and Retaining Walls." The paper discusses field conditions leading to earth pressures not normally considered in the structural analysis of retaining walls and abutments and the effect of such field conditions on the performance of the structure.

A report of the important Committee on Factors of Safety will be presented by its chairman, O. G. Julian, head of the Structural Division of Jackson and Moreland, Boston. Such interesting topics as the correlation of "factors of safety" and "factors of serviceability" with the probability of failure and of a bridge becoming unserviceable will be included. Finally, methods will be presented for combining probabilities of load effects with probabilities of resistance of structures, leading to computation of the factor of safety corresponding to a given probability of failure.

Papers on Bridge Loadings

The papers in another valuable session stem from work of the Committee on Bridge Loadings. Stewart Mitchell, consulting engineer of Sacramento, will speak on the subject, "Vehicle Loads and Bridge Design." Valuable data derived from loadometer records will be presented. These will show stresses in bridge members produced by actual vehicles operating under the Vehicle Code to establish critical frequency with regard to fatigue. Other data will be given on stresses produced by special-purpose vehicles, infrequently operated over the highways, for which provision must be made. Suggestions for more logical design procedures with regard to practical considerations will be the general theme.

Committee Chairman T. Y. Lin, professor of civil engineering at the University of California, will discuss "Load Factors for Prestressed Concrete Bridges." Basic design requirements will be presented, and the elastic theory and ultimate strength design will be compared. The significance of fatigue, permanent set, deflection, and camber limitations will be emphasized.

H. K. Stephenson, research engineer manager of the Structural Research Division of the Texas A. and M. College System, will discuss "Highway Bridge Loading Frequencies Based on Chance Grouping of Heavy Vehicles in Traffic." A new method, based on elementary probability theory, has been developed to provide a relatively simple mathematical basis for estimating how often any specified sequence or group of vehicles may be expected to occur on any part or length of bridge as a result of given or anticipated compositions, volumes, and speeds of traffic. In addition to making use of loadometer survey data, the method provides means for estimating frequencies of various intensities of live load resulting from chance grouping of heavy vehicles.

The great volume of bridge design calculations to be made in the next few years and the relatively few engineers available to do the work make the paper, entitled "Application of Digital Computers to Bridge Design," particularly timely. C. F. Scheffey, assistant professor of civil engineering at the University of California, is the author.

"The Vibration of Simple Span Highway Bridges" will be the subject of the first paper, in another session, to be presented by John M. Biggs, associate professor of structural engineering at Massachusetts Institute of Technology, co-author with H. S. Suer, senior structural research engineer, and J. M. Louw, research assistant, also of M.I.T. An analytical method for predicting the amplitude and frequency of highway bridge vibration will be discussed.

A. M. Lount, of T. O. Lazarides, Lount and Partners, Toronto, Ontario, will discuss the important subject, "Distribution of Loads on Bridge Decks," dealing especially with the transverse distribution effected by full moment diaphragms. Experimental work in the United States and Europe will be discussed in relation to the distributing effect of the deck slab only compared to the contribution of diaphragms. It will be shown that there is strong economic argument in favor of homogeneous grids.

Frequently questions are raised about the performance of prestressed concrete girders under repeated loading. C. E. Ekberg, Jr., associate professor of civil engineering at Lehigh University, will give some of the answers in a paper, entitled "The Factors of Safety of Pre stressed Concrete Bridges Against Fatigue," co-authored with R. E. Walther, research associate, and R. G. Slutter, research instructor, also of Lehigh. This paper will discuss the behavior of prestressed concrete bridges under repeated loadings on the basis of results of fatigue tests of full-scale hollow-box-section beams. Data from an extensive investigation of a type of multi-beam bridge will be used to aid in explaining what safety factors are generally to be expected in the structure.

There will be special interest in the paper, "Aluminum Applications for Highway Bridges," by J. M. Pickett, development engineer for the Aluminum Company of America, New Kensington, Pa., which will lead off the final session on Thurs-

day. This paper will include a discussion of aluminum alloys recommended and used for highway bridges, a résumé of the aluminum applications that have been and are now being fabricated or erected, and a brief look into the future of aluminum alloys for highway bridges.

"A Method of Selecting the Cross Section of a Composite Concrete and Steel T-Beam" is the subject of a paper by R. S. Fountain of the Bridge Department of the Georgia State Highway Department, and Ivan M. Viest, research associate professor at the University of Illinois. The paper develops an approximate method for selecting a trial section, which almost invariably yields the final section. A numerical example will illustrate the practical use of the method.

Zachary Sherman, associate professor of civil engineering at the University of Mississippi, will discuss "Testing Full-Size Post-Tensioned Slab and Beam Without Grouting," and W. E. Dean, assistant state highway engineer for the Florida State Road Department, will draw upon his extensive experience in the design and construction of bridges to discuss "The Behavior and Shortcomings of Prestressed Concrete Practice."

A luncheon is scheduled for Thursday, February 21, speaker and subject to be announced later.

Our New Board Committee Personnel

About a thousand members, or roughly one in every 39, "run" the Society in the sense that they man the committees—Board, professional and technical—that direct its multitudinous interests and activities. Of this personnel some 750 are working on Technical Division committees, and the others on the Board and professional committees. These are the few members to whom so many other members owe so much.

At the Annual Convention each year the Board of Direction confirms the appointment of new ASCE committees, consisting of the Committees of the Board, Auxiliary Administrative Committees, Professional Committees, Technical Committees, Task Committees, and Joint Committees. Committee personnel confirmed at the Pittsburgh meetings of the Board are given here.

Committees of the Board

All terms on Committees of the Board are for one year and expire in October 1957. Heading these committees is the **Executive Committee,** which advises the Board of Direction on all financial matters and acts in its stead between meetings. President Mason Lockwood is chairman, and the other members are Vice-Presidents Frank A. Marston, Glenn W. Holcomb, Francis S. Friel and Norman R. Moore and Past-Presidents W. R. Glidden and Enoch R. Needles. Mr. Lockwood is also chairman of the **Committee on Honorary Membership,** which exists to advise the Board of Direction regarding nominations for honorary membership. Vice-Presidents Frank A. Marston, Glenn W. Holcomb, Francis S. Friel and Norman R. Moore and Past-Presidents W. R. Glidden and Enoch R. Needles make up the remainder of the committee personnel.

Once every ten years, on years evenly divisible by ten(or more often if the Board wishes), the **Committee on Districts and Zones** has the responsibility of making recommendations to the Board concerning the boundaries of Districts and Zones. It consists of the four ASCE Vice-Presidents, with Frank A. Marston as chairman and Francis S. Friel as vice-chairman. The committee's next study is set for 1960. The new **Committee on Professional Conduct,** which advises the Board on all matters of an ethical nature referred to it, is headed by George S. Richardson as chairman and Clinton D. Hanover, Jr., as vice-chairman. The committee personnel also includes W. J. Hedley, L. A. Elsener, Frederick H. Paulson, and Louis E. Rydell. The four Vice-Presidents also make up the **Committee on Meetings,** with Frank A. Marston as chairman and Francis S. Friel as vice-chairman. This committee helps the Board set the time and place of Society meetings.

The Committee on Publications is responsible for the Society's general publication policy and also advises the Board on its publication budget. It is manned by six Directors, with Jewell M. Garrelts as chairman and Howard F. Peckworth as vice-chairman. The others are Mason C. Prichard, R. Robinson Rowe, Louis E. Rydell, and E. Leland Durkee. All applications of a special nature for admission and transfer are reviewed by the **Committee on Membership Qualifications,** headed by Don M. Corbett as chairman and Mason C. Prichard as vice-chairman. The others on the committee are Clarence L. Eckel, John P. Riley, Graham P. Willoughby, and R. B. Alexander.

Frank A. Marston is chairman of the **Committee on Division Activities.** The others are Francis S. Friel (vice-chairman), Jewell M. Garrelts, Lowell E. Gregg (chairman of the Research Committee), Finley B. Laverty, and Robert H. Sherlock. This important committee is the liaison between the Technical Divisions and the Board of Direction and makes recommendations to the Board concerning activities and budget requests of the Divisions. It also encourages cooperation between the Divisions and the Sections.

The **Executive Committee** of the **Conditions of Practice Committee** coordinates all the activities of the eight professional committees represented on it. Its other duties include reviewing the annual program, needs, and budget of each of these committees and making appropriate recommendations. Glenn W. Holcomb is chairman, and Norman R. Moore vice-chairman. The eight contact members are Finley B. Laverty (Junior Members), Frederick H. Paulson (Local Sections), Clarence L. Eckel (Student Chapters), Carey H. Brown (Engineering Education), Don M. Corbett (Registration of Engineers), George S. Richardson (Professional Practice), Graham P. Willoughby (Salaries), and L. A. Elsener (Employment Conditions).

Auxiliary Administrative Committees

The Auxiliary Administrative Committees are composed partly of members of the Board of Direction and partly of personnel from the membership at large. They include the **Committee on Application Classification,** which acts in an advisory capacity to the Committee on Membership Qualification and to the Board of Direction. Appointees to the committee are Albert Haertlein, chairman (1959); W. J. Shea, vice-chairman (1957); Harold L. Blakeslee (1958); and Graham P. Willoughby, Contact Member (1957). The alternates are Leslie G. Holleran, Van Tuyl Boughton, and Oliver W. Hartwell.

The **Committee on Budget,** which with the assistance of the Secretary is responsible for preparing the Society's annual budget, consists of Francis S. Friel (chairman), W. J. Shea, and Oliver W. Hartwell. The **Committee on Securities** is empowered to handle the Society's investments. Its members are Irving V. A. Huie, chairman; George W. Burpee; and Clinton D. Hanover, Contact Member.

John P. Riley is Board Contact Member on the **Annual Convention Committee.**

On the theory that too many names are wearying for one reading, announcement of the personnel of the Department of Conditions of Practice, Technical, Task, and Joint Committees will be postponed for later publication.

ASCE Restates Its Basic Publication Policy

With the advent of the Division Journals, there arose a need to restate the editorial purposes and scope of ASCE publications in order to establish their proper relationship in the overall program of the Society. In response to this need the Committee on Publications has restated the Society's basic publication policy, and the restatement was adopted by the Board of Direction at its Pittsburgh meetings (November issue, page 70). The entire policy statement is given here.

The basic objectives of each are as follows:

1. The PROCEEDINGS-Journals are the working technical references of the Technical Divisions of the Society.
2. The TRANSACTIONS constitute the permanent technical reference of the Society.
3. CIVIL ENGINEERING has a three-fold function: (*a*) as the official Society news medium, (*b*) as the primary outlet for papers dealing with the Department of Conditions of Practice, and (*c*) as the "Magazine of Engineered Construction" supplementing the Journal of the Construction Division.

Proceedings-Journals

The PROCEEDINGS-Journals have first claim on those Division-sponsored Convention papers and those submitted independently for publication in PROCEEDINGS, which a Division considers to have technical reference value. Evaluation of such papers shall generally be left to the judgment of the Publications Committee of the appropriate Technical Division, as defined in the Technical Publications Handbook. The Division Affairs section of the Division Journals shall be available for communications to registered members of the Division, supplementing the Society News Department of CIVIL ENGINEERING.

Transactions

The TRANSACTIONS shall comprise the papers and discussions selected from the PROCEEDINGS-Journals, which are judged to be of such technical value that they merit preservation in permanent form. Selection of TRANSACTIONS papers is a responsibility of the Committee on Publications of the Society, as described in the Technical Publications Handbook.

Civil Engineering

One of the primary objectives of CIVIL ENGINEERING will be to carry all Society news of possible interest to the membership.

Manuscripts dealing with interests of the Society's Department of Conditions of Practice, such as Ethics, Engineering Education, Local Sections, Student Chapters, Employment Conditions, Professional Practice, Salaries, and Junior Members, shall be made available first, and primarily, for publication in CIVIL ENGINEERING. Such papers may be contributed, or they may originate in meeting programs of the Society or its Local Sections.

A manuscript that, by reason of excessive length or otherwise, is inappropriate for production in CIVIL ENGINEERING may, at the discretion of the Executive Committee of the Department of Conditions of Practice, be produced separately as a PROCEEDINGS Paper in the Journal of the Board of Direction.

The technical articles in CIVIL ENGINEERING historically have related mainly to the construction of all types of civil engineering projects. CIVIL ENGINEERING will generally assume primary responsibility for the publication of papers sponsored by the Construction Division, and will have the first choice in the selection of such papers. Papers of general interest sponsored by Technical Divisions other than the Construction Division should be considered on their merits for publication in CIVIL ENGINEERING. As in the case of papers sponsored by the Department of Conditions of Practice, certain manuscripts—particularly comprehensive project or development papers, intended for formal discussion, or those of such length that they cannot be accommodated conveniently in CIVIL ENGINEERING—may be appropriate for the PROCEEDINGS Journal of a Technical Division. Such questions shall be resolved by the Publications Committee of the Technical Division, but it is considered that these comprehensive project development papers preferably should appear as articles in CIVIL ENGINEERING unless they possess unusual technical reference value.

Manuscripts for articles submitted independently for publication in CIVIL ENGINEERING and those developed by editorial initiative may be printed at the discretion of the editor.

Engineering Societies Honor Dr. Kettering

Charles F. Kettering, Hon. M. ASCE and noted inventor, is first recipient of the Kettering Award established in his honor by six leading engineering societies—ASCE, AIME, ASME, AIEE, AIChE, and SAE. Presentation of the award to Dr. Kettering took place at a special luncheon held during the AIEE's fall general meeting in Chicago. Shown, left to right, are Dr. E. George Bailey, founder and chairman of the Bailey Meter Co.; M. S. Coover, president of AIEE; Dr. Kettering; and Dean A. A. Potter, of Purdue University. Annual award of the honor is planned "for creative accomplishments for the benefit of mankind" in the field of discovery, invention, and improvement in designs or processes.

Memorial Shelter Honors A. P. Greensfelder

The late A. P. Greensfelder, Honorary Member of the Society and a leader in the construction industry, was honored on October 21, when a Memorial Shelter bearing his name was dedicated and opened to the public as a picnic and recreational area. The site of the memorial is a bluff overlooking Creve Coeur Lake in St. Louis County, Missouri.

Erected by St. Louis County as a tribute to Mr. Greensfelder's many years of leadership in the development of county parks, the A. P. Greensfelder Memorial Center symbolizes his life-long interest in reinforced concrete as a design medium. It consists of a circular upswept concrete roof, 50 ft in dia, supported on a single central column, faced with stone and containing three equally spaced fireplaces. A circular flagstone floor with stone benches completes the shelter. The roof slab, which weighs more than 100 tons, is designed as a double cantilever and tapers from 40 in. thick at the column edge to 4 in. thick at the rim. To minimize possible cracking, radial control joints divide the slab into nine equal sections.

Mr. Greensfelder had a 49-year career with the Fruin-Colnon Construction Co., of St. Louis, which he served as president and chairman of the board and, finally, as consultant. Long active in the ASCE Construction Division, he established and endowed the Construction Engineering Prize in 1939. He died April 17, 1956.

Do the Oldsters Want Jobs? ESPS Wants to Know

WM. N. CAREY, Secretary Emeritus ASCE

Are there many or few retired engineers, or others past 50, able and willing to take temporary jobs in engineering? The Engineering Societies Personnel Service, the employment agency for the engineering societies, wants to know. The Board of Directors of ESPS has asked me to pose the question. Being on the retired list myself, both from the army and from active professional work, and having served as a member and chairman of the Board of ESPS, I find the question well worth trying to answer.

The current shortage of engineers and scientists is a well known fact. Continuous advertising in the newspapers of metropolitan areas and the quarterly combing of our campuses emphasize the need for young engineers and scientists. The supply does not begin to meet the demand for young men in these fields. Is the shortage confined to the young men, or does it include men in the older brackets in industry and government? Is it possible partially to meet today's need for engineers and scientists by temporary employment of men no longer young but willing and able to perform the required task? If such men are available and employers want them as temporary help, the task of trying to get employers and prospective employees together will be undertaken by ESPS.

It is realized, of course, that there are deterrents and complications in any attempt to employ older or retired engineers even temporarily on routine work. Some of the largest companies, whose engineer recruitment efforts are the most impressive, simply will not hire engineers or scientists over 35. Their reasons are sound where permanency in an organization is the objective. But temporary, day by day or week by week, employment of men to help level off peak loads need not affect the retirement system of a company or interfere with lines of promotion, apprenticeship jobs, and other factors vital to employment planned on a permanent basis.

From the viewpoint of the older prospective employee—the 50 plus man or the Social Security beneficiary of over 65—there are deterrents too. These would tend to dampen the desire to take a by-the-day or week position as a temporary helper but not an integral part of a going organization. Granting the handicaps which exist from the viewpoint of both employer and prospective older employees, it still seems reasonable that some of the shortage of engineers could be met by greater use of the older members of our profession now unemployed or retired.

ESPS does not know now how many such potential employees are available. If *you* are an engineer or scientist over 50, unemployed or retired, and if you are willing and able to take a temporary job, please tell ESPS. Send a brief letter to the Engineering Societies Personnel Service, 8 West 40th St., New York 18, N.Y. Just state your professional branch, your specialty, your age, and refer to this article. If the response is adequate in numbers, the Board of ESPS will attempt to work out a plan to bring these older engineers and scientists together with the industries needing them.

It should be borne in mind, of course, that ESPS with offices in New York, Chicago, Detroit, and San Francisco continues ready to help any engineer or scientist of any age better his position or to obtain one. ESPS also continues to try to locate the particular engineer or scientist any specific employer may want. These have been its routine tasks for more than 25 years. The proposal discussed here contemplates a special kind of placement from a yet unknown number of "prospects," 50 plus in years, who still desire to help themselves and their profession in the work of the nation.

ASCE MEMBERSHIP AS OF NOVEMBER 9, 1956

Members	9,271
Associate Members	12,198
Junior Members	17,929
Affiliates	72
Honorary Members	44
Total	39,514
Nov. 9, last year	38,756

Architects Named for Engineering Societies Center

The first definite step toward construction of the new Engineering Societies Center—to be built on a mid-Manhattan site—has been taken with the award of a contract for preliminary architectural studies to Shreve, Lamb & Harmon Associates, of New York. Announcement of the granting of the contract comes from United Engineering Trustees, Inc., joint corporate agency of the four Founder Societies. The architects named are well known as designers of the Empire State Building and, more recently, the new Brooklyn Supreme Court Building. No details as to specific location, cost, or date of completion of the new building have been announced.

The present 16-story Engineering Societies Building houses the four Founder Societies. A fifth society, the American Institute of Chemical Engineers, will be included in the Center project. At a recent meeting of UET, at which the architectural contract was granted, the UET board of trustees approved the AIChE as a member. This action awaits ratification of the other four societies. Preliminary plans will probably be completed early next year. The decision to build on a mid-Manhattan site was based on studies indicating the accessibility of the area to railroad and airline terminals and Convention hotels.

Financing is expected to run into "several million dollars." In addition to the contributions of the various Founder Societies and their members UET, which has been charged with the responsibility of the planning, construction, and financing of the new structure, has received assurance of the cooperation of a group of industrialists and educators toward the required fund. This group, headed by Dr. Marvin J. Kelly, president of Bell Telephone Laboratories, Inc., stated on June 8, 1955, in a letter to UET and its constituent societies, its readiness to assist in the financing on the selection of a city following a broad and careful study of all possible sites.

McKinsey & Company, management consultants, surveyed all factors involved in the offers advanced by several cities and recommended New York as the best location for the center. In a report forwarded to the governing boards of the societies on June 22, 1956, a Special Task Committee of Fifteen (made up of three representatives of each of the five societies involved) reviewed the various considerations and urged that mid-town New York be chosen for the site. It was suggested that if the present site on 39th Street should not prove feasible, another mid-town location be chosen. The proposal required approval of each of the five societies concerned, and this has been obtained.

Walter J. Barrett, transmission maintenance engineer of the New Jersey Bell Telephone Co., Newark, and a resident of Glen Ridge, N.J., has been reelected president of UET for another year. Mr. Barrett first became president last year when the new Center project was being vigorously discussed. His reelection continues the direction of the biggest UET program since the organization was created in 1904.

Short Form for Transfer Available

Associate Members who are qualified should seek transfer to Member grade. To make the process easy a special short form of application is available. Reference to only three Members or Associate Members who have personal knowledge of you and your work is required. Signatures of the references are not needed, but courtesy suggests obtaining permission from each reference to use his name on the application.

The applicant for transfer to Member grade need list his engagements and experience only since filing his application for Associate Member. However, he will find it advantageous to list engagements prior to that date, particularly those involving broad responsibility for engineering work of major importance—that is, responsible charge of the kind required for admission or transfer to Member grade.

Annual dues for both grades are identical. However, the entrance fee for Member grade is $30—only $5 more than the entrance fee for the Associate Member grade. This difference is paid only once, and that upon notification of transfer.

Many of the Society's 12,198 Associate Members have the age and experience to qualify them for the higher rank of Member. Modesty deters a few from applying for transfer; inertia deters many others.

In this higher grade there is the advantage of greater professional prestige; the personal satisfaction of having been qualified by one's peers; the recognition of professional attainment in courts of law. You will also have assisted the Society's effort to make its membership grades truly reflect professional stature.

These are the minimum qualifications for Member: age, at least 35 years; active practice, at least 12 years, of which graduation from a recognized engineering school counts for 4 years; responsible charge, for at least 5 years, of engineering work of considerable magnitude or complexity; and, finally, ability to conceive or plan or design as well as to direct important engineering works.

The short form of application for transfer is available from an officer in your Local Section or, if more convenient, from the Executive Secretary at Society headquarters. You can help yourself professionally and aid the Society in recognizing the professional attainments of its members.

J. Waldo Smith Hydraulic Fellowship Is Available

Applications are being received for the J. Waldo Smith Hydraulic Fellowship for 1957–1958. The fellowship offers a cash stipend of $1,500, payable October 1, 1957, plus as much more to a total of $2,000 as may be required for physical equipment connected with the research. Offered every three years, it will be available again for the 1960–1961 academic year.

The scope of the fellowship is restricted to research in the field of experimental hydraulics as distinguished from purely "theoretical hydraulics." To this end emphasis is to be placed on "practical experiments designed and executed for the purpose of advancing knowledge with respect to the laws of hydraulic flow, rather than to the type of research which proceeds on the theory of mathematical analysis based on assumptions of unknown validity. The essence of the purpose of the research is to test the assumptions which are currently made and also to develop a better understanding of fluid-flow."

Applicants should be less than 30 years old and either an Associate or (preferably) a Junior Member of ASCE. Other conditions ruling the fellowship are given in the ASCE Official Register for 1956 (page 145). Applications must be sub-

mitted to the Executive Secretary before May 1, 1957. They should include three copies of a summary of the applicant's training, experience, and personal data with a recent photograph and an outline of his proposed research project; three copies of a letter from the department head appraising the applicant's qualifications for the project; one transcript of his academic record; and a record from a dean or similar officer certifying that the applicant is eligible for full-time graduate study and that the proposed project has administrative approval.

The applicant must submit this material through the appropriate faculty officer who in turn transmits it to the Executive Secretary of ASCE. Administration is in part through the institution which invites cooperation. The winner will be announced after the 1957 summer meeting of the ASCE Board of Direction.

EJC Establishes Monthly Newsletter

To keep both its member societies and engineering editors alert to its activities, Engineers Joint Council has just issued Vol. I, No. 1 of "Engineer," a monthly newsletter. The informative one-page publication goes to Board members of constituent societies, chairman of local sections of constituent societies, editors of trade publications, chairmen of local engineering societies, and editors of constituent society publications.

Its purpose will be to provide a quick digest of EJC board and committee actions, which can be read at local meetings for the information of individuals, and a guide for editors in their search for news of the engineering profession as a whole. Items from EJC member societies, which are of general engineering interest, will be welcome. They should be addressed to "Engineer," in care of EJC, 29 West 39th Street, New York 18, N. Y.

Revised Manual on Shell-Roof Design

A revised and corrected version of ASCE Manual of Engineering Practice No. 31, covering "Design of Cylindrical Shell Roofs," is now available. The new printing of this valuable and significant work incorporates many improvements and corrections suggested by readers in the four years since the manual was first published. Copies may be obtained by using the coupon on page 123.

More Research Funds Available To Engineering Foundation

Engineering Foundation will be able to take on more research projects with the income from a bequest for the benefit of the Foundation to United Engineering Trustees, Inc., custodian of the Foundation's funds. The bequest of some $425,000 is currently being made available to United Enginering Trustees, Inc., from the estate of the late Edwin H. McHenry, civil engineer and railroad executive, of Ardmore, Pennsylvania, who died August 21, 1931.

In his will Mr. McHenry provided that upon the death of the last beneficiary his entire estate should go to United Engineering Trustees, Inc., which is empowered to pay the net income from it to Engineering Foundation for a period of thirty years. The will expressly stipulates that Mr. McHenry's gift "constitute and be kept as a special trust fund for the furtherance of research in science and engineering" and that it be dedicated to the memory of his wife, Blanche H. McHenry. At the expiration of the thirty-year period the principal of the fund held by United Engineering Trustees, Inc., may also be applied to Engineering Foundation research projects.

A native of Cincinnati, Mr. McHenry was chief engineer for the Northern Pacific and Canadian Pacific railways at various stages in his career, and vice-president in charge of engineering of the New York, New Haven & Hartford Railroad. The electrification of the New Haven road, carried out under his direction, was the first large-scale undertaking of its kind in the United States. He was a member of the American Society of Civil Engineers and the Engineering Institute of Canada.

Mr. McHenry's bequest is especially timely, coming as it does when both government and industry are stressing the need for more research in science and engineering. Engineering Foundation, which was established in 1914, currently administers the income from a $1,500,000 fund dedicated to engineering research. Over the years the Foundation has made valuable use of the relatively modest income from this fund in launching and supporting new research programs, some of which have later developed into large and important projects.

New Pipeline Division Begins Operation

Not every day, or even every year, does the Society set up a new Technical Division. Its fourteenth and newest Division—the Pipeline—is now a going concern following formal inauguration ceremonies at the Pittsburgh Convention. The new Division, which is an outgrowth of the Pipeline Committee of the Construction Division, recognizes the extensive development of the pipeline industry and its importance in the national picture.

The Pipeline Committee has been active in Society affairs for several years. Its first technical papers as a Division will be presented February 19 and 20, 1957, at the Society's Jackson Convention (page 72). Other programs are already planned for the Chicago Convention in February 1958 and the Portland (Ore.) Convention in June 1958.

The Division's Executive Committee has been announced as follows: Eldon V. Hunt, chief engineer, Alberta Gas Trunk Line Co., Calgary, chairman; Arthur E. Poole, president, Hallen Construction Co., Island Park, N.Y., vice-chairman; Joseph B. Spangler, Transcontinental Gas Pipeline Co., Houston, secretary; Fred Culpepper, Jr., project manager, Ford, Bacon & Davis Construction Co., Alliance, Ohio; and Stanton E. Huey, consulting engineer, Monroe, La.

In announcing the Division's plans, Chairman Hunt said: "Many civil engineers are in the pipeline industry, which cuts across most phases of engineering represented by the Society. The Division is in the organization in which we 'pipeliners' can, most effectively, coordinate our work and technical progress with other fields of engineering."

The purpose of the Division is to advance and correlate scientific knowledge and promote and coordinate economic development and construction of engineering projects in connection with the transmission of liquids, gases, or solids. It will also promote and further the mutual utilization of the established codes for pressure piping among pipeline, highway, and railroad groups and public authorities.

New Annual Report

A copy of the new-style 1956 Annual Report, summarizing every phase of ASCE activity, has now been sent to every member of the Society. In authorizing the new expanded format, the Board specifically endorsed the principle that an informed membership is a strong membership, and urged everyone to give the Report a careful review.

In describing the accomplishments in such fields as technical publications, research, salaries, education, conditions of practice, international affairs, and many other areas of professional interest,

the report emphasizes how many have voluntarily contributed to the progress being made in civil engineering.

If for any reason you have not received your copy, you can get one free on request to headquarters.

Technical Publications Handbook Available

Persons writing papers for publication by the Society will expedite the review and publication procedure by complying with the requirements given in a new Technical Publication Handbook, which is available on request. The new pamphlet represents the joint effort of publications committeemen in each of the thirteen Technical Divisions and the editors at Society headquarters.

Publication of a new Technical Publications Handbook was necessary because of the many changes made in the method of producing and distributing the technical papers of the Society since the publication of Proceedings Paper No. 290 in October 1953. Introduction of the Division Journals and adoption of the photo-offset process of reproducing papers were among the major changes in publication policy dictating the need for a new book of instructions to authors, reviewers, and editors.

Copies of the Handbook may be obtained from Society headquarters.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication.)

Mid-South Section Holds Annual Meeting

Nearly 250 Mid-South Section members thoroughly enjoyed the Section's annual fall meeting, held in Vicksburg, November 1–3. As an index to the good size of the gathering, the entire Section membership is 531 scattered over a three-state area. The excellent technical program, the opportunity to tour the Waterways Experiment Station, and the renowned hospitality of General Chairman James W. Dement and his committee of Vicksburg Branch members were compelling factors in the good turnout. Section Vice-President Fred R. Brown did the honors for President Larry Tvedt, who is on the sick list, and President Richard G. Ahlvin presided for his Branch.

An Early Bird Party on board the steamer, "Sprague," former "Queen of the Mississippi," got the meeting off to a good start on Thursday night.

Developments in concrete technology were discussed in Friday's technical program by Thomas B. Kennedy, chief of the Concrete Division of the Waterways Experiment Station, and F. W. Sims and L. R. Barnett, of the Little Rock Office of the Corps of Engineers. There were also interesting papers in a student competition with presentations by Ralphe J. Burcham, of the University of Arkansas (first prize); Charles Knott, of the University of Mississippi (second prize); and Garland Wright, of Mississippi State College (third prize). E. S. Kirkpatrick, assistant to the Secretary, presented the prizes during the banquet. Vice-President Norman Moore was banquet toastmaster, and Professor Thomas Stallworth, of the University of Mississippi, was the principal banquet speaker. Professor Stallworth related his experiences in Italy where he was a Fulbright Scholar in the 1955–56 academic year.

New Section officers are R. W. Sauer, president; J. R. Bissett, vice-president; and Earl C. Meserve, secretary-treasurer.

ASCE Vice-President Norman R. Moore (left) discusses with Prof. Tom Stallworth, of the University of Mississippi, his recent experiences in Italy as holder of a Fulbright Award. Professor Stallworth was speaker at the banquet on November 2.

Frederick R. Brown (left), retiring vice-president of the Mid-South Section, congratulates Raymond W. Sauer on his election as Section president. Secretary - Treasurer Earl C. Meserve looks on.

Why nothing but Asphaltic construction would do for this new approach to the Golden Gate Bridge...

According to the State of California's own averages . . . the savings effected by using Asphaltic Concrete on the new Waldo Grade Project were $78,564 per mile. Or . . . $290,115 for the 3.68-mile job. A whopping big 43.8% saving!

The difficult job of repaving and widening the Waldo Grade on U. S. 101 is completed. And traffic is now rolling on wide ribbons of velvet smoothness.

Asphalt construction was picked for many reasons. The traditional ones, of course. First low cost. Fast working characteristics. Durability. Smooth riding. Skid-resistance. Economical maintenance.

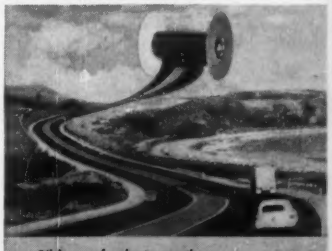
But there was another important consideration, too. The added width of this project had to be constructed in steep, hilly terrain. Nearly all fills were the side fill variety. Thus, it was *anticipated* that some settlement would occur at the junction of the new fill and the original ground.

Cracking *did* occur in the dense graded mix. Cracking that would have proved costly, time-consuming . . . if not an insurmountable handicap . . . for any other paving material but Asphalt.

With Asphalt construction, however, the cracking was filled . . . the wearing course laid . . . and smooth riding assured for generations.

WILLIAM A. RUSSELL

The paving of this outstanding Waldo Grade job was done by the A. G. Raisch Company . . . under the supervision of "Bill" Russell. Mr. Russell writes: *"I have used Asphalt construction for 25 years. I firmly believe that Asphalt can provide the finest surface anywhere it is placed."*



Ribbons of velvet smoothness . . .
MODERN **ASPHALT** HIGHWAYS

THE ASPHALT INSTITUTE, Asphalt Institute Building, College Park, Maryland

Ventures in Public Relations at Section Level

V. G. THOMASSEN, President Philadelphia Section

The civil engineer's position in the community and the vital need for public understanding and favor have too long been neglected in our thinking and planning. Now, in the face of the engineering manpower shortage, the lessened interest in science and engineering on the part of our younger generation with its threat to our national safety, we find it imperative to review our numerous activities and investigate the causes of the situation facing us.

Since each Local Section in its own community carries the responsibility of properly representing the Society, the appropriate publicizing of Section activities becomes one of our most urgent obligations.

The Philadelphia Section enjoys affiliation with the Engineers Club of Philadelphia, which permits it to meet at and use the many facilities of its Club House. This affiliation it shares with 21 other organizations, mostly local sections of national societies. In the active and admittedly difficult task of competing for public favor with these affiliates, as well as hundreds of other and better known groups, we have followed the sage advice, "In Union There Is Strength."

Wherever possible, our committee coordinates its news releases with those of the public relations departments of large industrial corporations when their interests are covered in our monthly programs. We have not hesitated to engage in joint activities with other groups at meetings or public affairs. In Philadelphia, engineers are privileged, from time to time, to be represented on a TV program, Don Bennett's "The Big Idea," and a radio program, "Meet the Engineer," sponsored by the AIEE and presented every Saturday night at 6:45 p.m. We have been tentatively advised that our Section will receive an invitation to join a series of 15-minute TV programs, sponsored by a technical organization and publicizing the contributions by engineers to the nation's development.

The Right Committeemen

The ferreting-out for committee personnel of willing, aggressive, sales-minded individuals with ability and with the necessary contacts has been an encouraging factor. This was evidenced, particularly, in one of our most successful ventures in community activity. Several years ago our Section was asked to share the burden of a survey of some 4,000 to 5,000 centrally located city buildings for possible shelter against atomic attack. Along with and in competition with other organizations, our Section rose magnificently to its task. A one-letter appeal for volunteers, with return post card, brought a 20 percent response from our 400 dues-paying members. A concerted drive upon industrial, commercial, civic and other organizations produced a total volunteer force of some 250 engineers headed by the Philadelphia Section, which not only successfully completed its one-third share of the survey, but accounted for over 60 percent of the total number of structures. The resultant publicity—a series of feature articles by a leading reporter—emblazoned the survey, referred to it as a $150,000 contribution on the part of engineers, and spotlighted the part played by our Section and its 80 volunteer members.

Another of our publicity triumphs was the Section's follow-up of the Society's campaign to determine the Seven Wonders. Paced by ASCE headquarters, our Section's enterprising public relations representative sold the idea to the Sunday editor of the Philadelphia *Inquirer*, and the day before our Atlantic City Convention opened in June 1954 the Section's selections for the Seven Wonders were announced in the Sunday Supplement. Here aggressive planning and salesmanship won out over many competing attractions for Sunday space.

Each year our joint efforts in the Engineering and Technical Societies Council of Philadelphia have furnished speakers at local and suburban schools to encourage the study of engineering. Our Junior Members have a Speaker's Bureau, which supplies speakers to Student Chapters on request. A junior and senior contact member is assigned to every college in our area with a Student Chapter. Joint action with neighboring universities and colleges in promoting and publicizing symposiums, active participation in the Joint Nuclear Congress to be held in Philadelphia in the Spring of 1957 (under sponsorship of the Society and other organizations), the arrangement of sight-seeing trips covering local construction projects, to which students, contractors, and interested organizations are invited, suggest some of the many and varied types of public relations activities.

Our Foundation Division has successfully conducted an active study and discussion group attended by geologists, contractors and others. As a result of this group's exhaustive study of the use of creosoted piles above the ground-water table and its recommendations to city authorities, it is expected that the building code will ultimately be modified.

The Section is further cooperating in a program of building code revisions through its group of local practicing consulting structural engineers, which it is expected will ultimately exert a profound influence on design and construction practices in Philadelphia. This Section group is the nucleus of a permanent committee.

Cooperative Endeavors

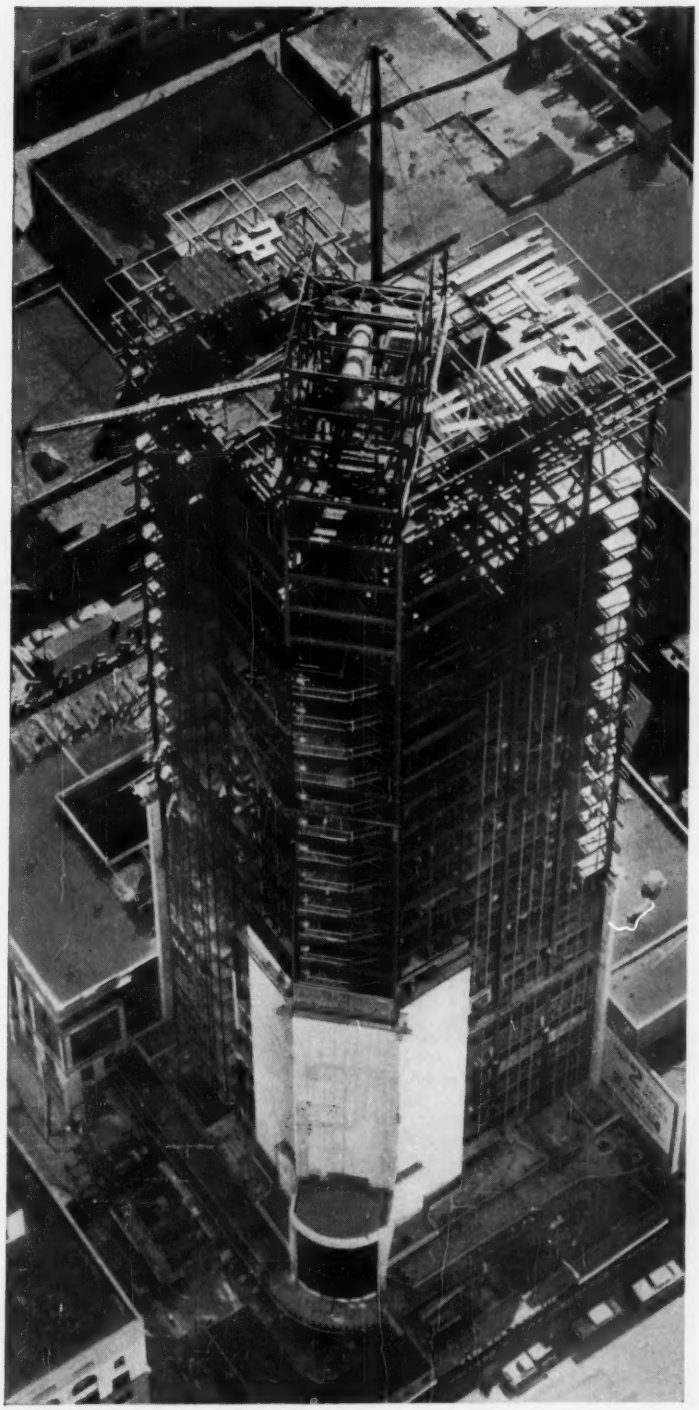
An employment bureau is operated by all the affiliates of the Engineers Club. This self-supporting operation is available to all engineers at lower cost than commercial employment agencies. Started as a philanthropic organization during the depression, the bureau has since become a regular agency and successfully continues to place engineers in brackets ranging from beginners' salaries to well over $12,000 a year.

National Engineers Week, an activity sponsored by the National Society of Professional Engineers, gave us the opportunity to join in hailing our new Vice-President Francis S. Friel as the Engineer of the Year (1956) in the Philadelphia area. This joint activity reached not only the news columns, but the editorial section of newspapers and *Engineering News-Record* and CIVIL ENGINEERING.

We look forward with hope to the day when, along with the signs on all construction projects announcing the name of the contractor, the architect and the bricklayer, there will appear the name of the engineer; and when in real estate columns the engineer will receive his share of the credit to which he is entitled. Continued consideration of the value of this type of publicity, together with the urge to get it, will bring the rewards we seek.

For our members, we have for years carefully nurtured our Section publication, *The News*, an eight-page pamphlet, published monthly during our eight-month season, which has served our Section nobly. Today *The News* has been discontinued. In its place we now are served by a new venture in the field of public relations.

The *Delaware Valley Announcer*, a new and enlarged publication of the Engineers Club of Philadelphia, has undertaken to provide the service for its affiliated organizations that previously was obtained through their own smaller publications.



Architect: Edwin A. Keeble Associates, Inc.; *Structural Engineer:* Ross H. Bryan
General Contractor: J. A. Jones Construction Co.

Bolted Frame For Nashville Building

Here you have a bird's-eye view of the steelwork for the 30-story home office building erected at Nashville for the Life & Casualty Insurance Company of Tennessee. The framework for the 409-ft structure, weighing about 3,350 tons, was erected quickly and economically by means of bolting. Bethlehem High-Strength Bolts join the structural members.

Bethlehem High-Strength Bolts are ideal for saving time in erecting structural steel. The bolts are used with hardened washers, and are installed by a two-man crew, one using a holding wrench, the other a calibrated impact wrench. Installation is accomplished in seconds, yet each joint is tight and sound.

OTHER ADVANTAGES

High-strength bolting is relatively free from noise, as the impact wrench is less noisy than a riveting gun. Besides, there are no fire hazards involved, for the bolts are installed cold.

Bethlehem High-Strength Bolts are made of carbon steel in a wide size range. They are heat-treated by quenching and tempering to meet the requirements of ASTM Specification A-325. For full details, drop a line to the nearest Bethlehem sales office.

SEND FOR NEW BOOKLET

We recently issued a 24-page, two-color booklet on high-strength bolting. It is profusely illustrated, and contains a wealth of material for reference. Write today for your copy.

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BETHLEHEM STEEL

The first issue contains around 100 pages —forty of them paid advertising pages costing about $500 each. Not just another engineering magazine and not a house organ, this new publication brings to all of the 25,000 certified engineer subscribers the message of industry, commerce, banking, transportation, real estate and the myriad other activities of the Delaware Valley and tells the valley the story of the accomplishments of its engineers. It provides each affiliate a full column or more of editorial space for publicizing its activities and functions, together with additional space for items of interest from their national organizations. The magazine is mailed free to all its certified subscribers—members of not only the 21 affiliated organizations but of additional groups affiliated in the venture

Space and time do not permit a more detailed report or analysis of our public relations activities. Increasing vigilance is required to capture the many opportunities offered for: (1) publicity through press, radio, and TV; (2) development of the contacts so eagerly welcomed by schools and colleges; and (3) participation in community activities, cooperation with local authorities, and leadership in the maintenance of high-quality engineering.

In closing I express my indebtedness to the past-presidents and board and committee members of our Section who collaborated in the preparation of this article. Guided by the experience of our national organization and our public relations consultant and eagerly seeking to learn of the numerous successful ventures of our brother Sections, the Philadelphia Section takes its place in the earnest effort to further the aims of our beloved Society and to bring to the attention of the nation at large the story of the accomplishments in war and peace of the ASCE engineer.

(This article is based on Mr. Thomassen's address at the Society's Pittsburgh Convention, presented as part of a symposium on "The Civil Engineer and His Public Relations," with Frank L. Weaver presiding.)

Scheduled ASCE Conventions

JACKSON CONVENTION
Jackson, Miss.
Hotel Heidelberg
February 18–22, 1957

BUFFALO CONVENTION
Buffalo, N. Y.
Hotel Statler
June 3–7, 1957

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 14–18

Junior Activities Committee of Kansas City Section reports on recent survey of profession as part of panel discussion of "Engineer Employer-Employee Relationships in the Kansas City Area" at Section's October 9 meeting (page 86). Shown here, in usual order, are W. G. Richey, E. C. Balke, R. C. Bergendoff, J. G. Stinson, A. R. March, and R. E. Vansant. During the survey 684 questionnaires were distributed to engineers in the area, and 398 were returned.

The **Arizona Section's** new **Phoenix Branch,** authorized for the convenience of Maricopa County members, will make a special effort to activate the many inactive Junior Members of the area. Prof. Amos Hoff, head of the engineering department at Phoenix College, was featured speaker at the organization meeting on October 9. His topic was the 24-in. reflector-type telescope recently intalled at the college.

New **Central Ohio Section** officers are Charles B. Smith, president; Roy T. Underwood, first vice-president; Robert W. Duis, second vice-president; and Orison H. Jeffers, secretary-treasurer. All reside in Columbus.

Many interesting phases of city planning were brought out in a panel discussion highlighting the **Cincinnati Section's** October meeting. The experts were George Hayward, executive secretary of the Citizens Development Committee, who discussed the citizen's viewpoint and the opportunities for his participation; Herbert Stevens, director of planning for the city, who spoke on the Planning Commission and its activities; and Charles H. Stamm, director of urban development for the city, whose topic was urban renewal. Ladislas Segoe, consulting engineer and city planner, moderated the symposium. Feaured speaker at the November meeting was Gregory P. Tschebotarioff, authority in soil mechanics and professor of civil engineering at Princeton University, who cleared up some of the problems involved in tunneling in soft ground.

Of much interest to **Cleveland Section** members was the October meeting program, devoted to construction and installation of two 20-in.-dia. pipelines across the Straits of Mackinac between St. Ignace and Mackinaw City. The speakers were Joe Traxell and Fred Krause, respectively project superintendent and designer on the project for the Merritt-Chapman and Scott Corp. This strategic four-mile section was the most difficult portion of the new 643-mile pipeline extending from Superior to Port Huron—an important project that makes it possible to move 120,000 barrels of oil a day from the Alberta oil fields to refineries at Port Huron and Sarnia regardless of weather.

The **Connecticut Section's** October meeting took the form of a guided tour of the Southern New England Telephone Company's new Equipment Building at New Haven. Following a dinner in the company cafeteria, George M. Tomask, crossbar installation expert, and other members of the engineering department conducted the inspection of the building and explained construction features.

The **Dayton Section** was host on October 13 to the annual meeting of the District 9 Council. The all-day business session—under Council Chairman Joseph C. Webber, of Toledo—was devoted to Society affairs and to Council activities at both Society and Local Section levels. Vice-President-Elect Norman R. Moore was featured speaker, and former Vice-President G. Brooks Earnest and former Directors Warren W. Parks and Clyde T. Morris led discussion from the floor. New Council officers, elected during the session, are W. G. Hamlin (Cincinnati Section), chairman; F. F. Schrader (Kentucky Section), vice-chairman; and C. H. Kurtz (Toledo Section), secretary-treasurer. The program included a "get-acquainted" party on Friday evening; a luncheon at the Engineers Club on Saturday featuring a color movie of technical advances we may expect to see by 1975; and a banquet and dance on Saturday night. Prof. K. B. Woods, head of

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Alabama Power Company
Arkansas-Missouri Power Company
Arkansas Power & Light Company
Boston Edison Company
Carolina Power & Light Company
Central Hudson Gas & Electric Corporation
Central Illinois Public Service Company
Central Louisiana Electric Company, Inc.
Cia Cubana Electricidad
The Cincinnati Gas & Electric Company
City of Jacksonville, Florida
City Public Service Board — San Antonio
The Cleveland Electric Illuminating Co.
Columbus & Southern Ohio Electric Co.
Consolidated Edison Company
Consumers Power Company
Duke Power Company
Electric Energy, Inc.
Florida Power Corporation
Florida Power & Light Company
Georgia Power Company
Gulf Power Company
Hartford Electric Light Company
Indiana & Michigan Electric Company
Indiana-Kentucky Electric Corporation
Jersey Central Power & Light Company
Kentucky Utilities Company
Long Island Lighting Company
Louisiana Power & Light Company
Mississippi Power Company
Mississippi Power & Light Company
Monongahela Power Company
Montaup Electric Company
Ohio Edison Company
Ohio Power Company
Pacific Gas & Electric Company
Pennsylvania Power Company
Philadelphia Electric Company
Public Service Company of Indiana
Rockland Light & Power Company
South Carolina Electric & Gas Company
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Tennessee Valley Authority
The Tucson Gas, Electric Light & Power Co.
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POWER COMPANIES SELECT INGALLS

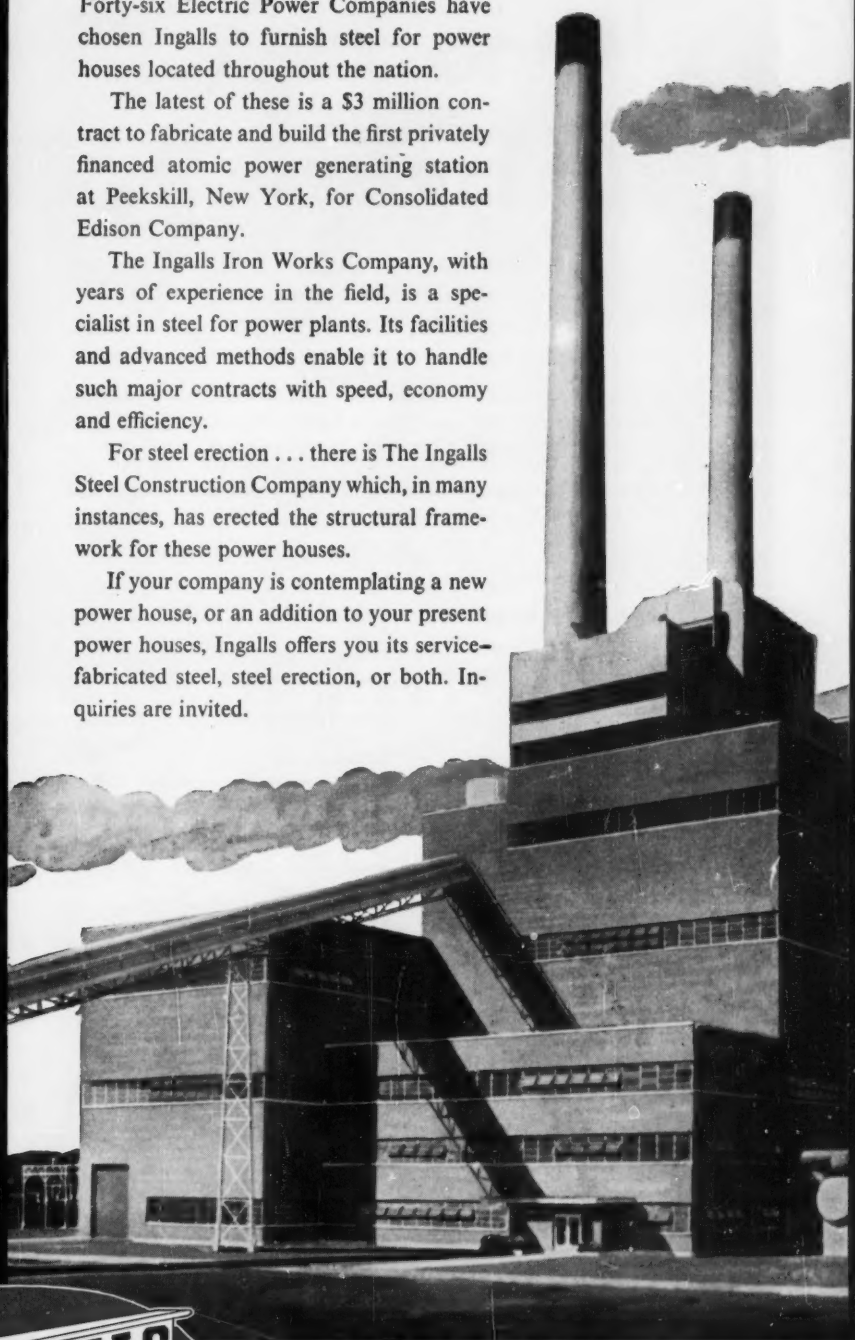
Forty-six Electric Power Companies have chosen Ingalls to furnish steel for power houses located throughout the nation.

The latest of these is a $3 million contract to fabricate and build the first privately financed atomic power generating station at Peekskill, New York, for Consolidated Edison Company.

The Ingalls Iron Works Company, with years of experience in the field, is a specialist in steel for power plants. Its facilities and advanced methods enable it to handle such major contracts with speed, economy and efficiency.

For steel erection . . . there is The Ingalls Steel Construction Company which, in many instances, has erected the structural framework for these power houses.

If your company is contemplating a new power house, or an addition to your present power houses, Ingalls offers you its service–fabricated steel, steel erection, or both. Inquiries are invited.



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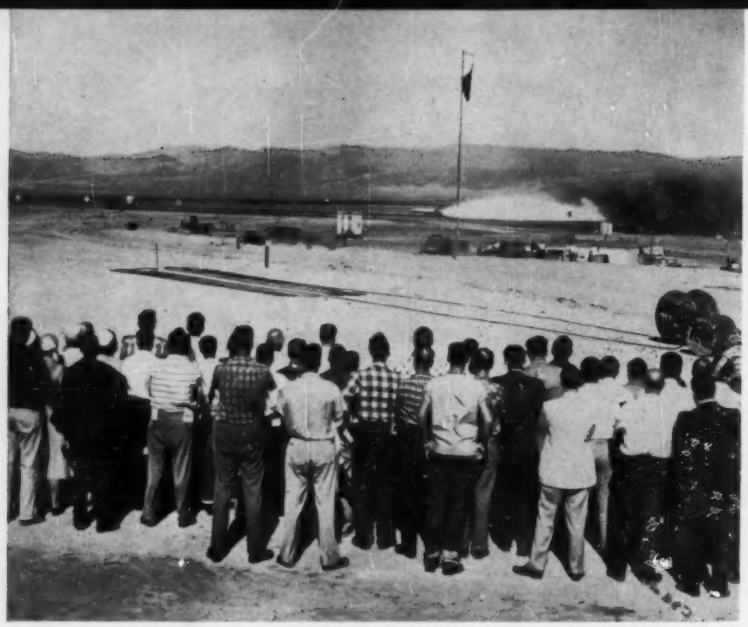

Some of the 1,200 engineers attending the field trip to the Naval Ordnance Test Station at China Lake—sponsored by the Desert Area Branch of the Los Angeles Section on October 13—view a rocket sled at the Supersonic Naval Ordnance Research Track blasting off on a 1,100-mph demonstration run, one of the highlights of the all-day trip. So enticing was the program that 2,315 requests for reservations were received. Another trip was arranged for the benefit of the group of almost 1,200 who had to be turned away. The Los Angeles Section aided the Desert Area Branch in its super-successful planning. Dean E. Stephan was chairman of the China Lake trip.

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the civil engineering department at Purdue told the banquet group about his construction experiences in the far North. A. M. Friend is president of the host Section.

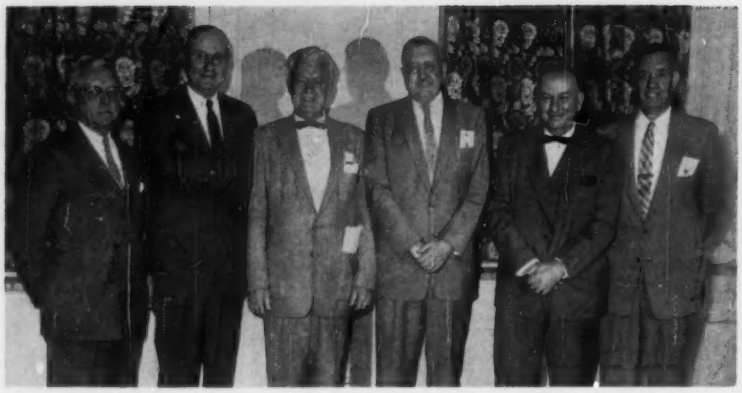
District 10 activities were reported at the **Georgia Section's** November meeting by Warren S. Mann and Robert O. Harris. Gordon B. Dalrymple told about the Knoxville Local Section Conference. Section President Byron A. Bledsoe addressed the October meeting of the **Savannah Branch** on the functions of ASCE Sections and Branches. Officers of the newly formed **Albany Branch** are Ralph S. Howard, Jr., president; George S. Jenkins, vice-president; and J. Roy Fraser, secretary-treasurer. James L. Lindsay is Branch editor. The industrial development of the Central Savannah River area was discussed at the October meeting of the **Central Savannah Valley Branch** by Allen H. Douglas, executive director of the Committee of 100.

Forty years of engineering progress in Chicago were reviewed in the special program marking the **Illinois Section's** fortieth anniversary dinner on October 11. Chicago Mayor Richard J. Daley led off with a glimpse of the Chicago of the future. He was followed by Virgil E. Gunlock, chairman of the Chicago Transit Authority, who reviewed the role of public construction in the development of our second metropolis. The role of private construction was covered by Carl A. Metz, partner in Shaw, Metz & Dolio. ASCE Director-elect Howard F. Peckworth was the able master of ceremonies. There was a turnout of about 225 members and their wives. Other recent Section doings include an inspection trip to the Calumet Harbor Development of the Chicago Regional Port District on November 3, and a Life Membership Luncheon on November 9. The certificates went to Lawrence B. Baker, David A. Decker, Carroll R. Harding, William N. Mitchell, and Thomas E. Wetzler.

The median annual earning for civil engineers in the Kansas City area in 1955 was about $7,000, the average earning $9,140, and the average earning considered deserved, on the basis of experience and qualifications, $10,625. These are some of the findings of a significant survey recently completed by the Junior Activities Committee of the **Kansas City Section**. The Survey also showed that 89 percent of those questioned are satisfied with their profession. A total of 684 questionnaires was distributed to members, affiliates, and non-members, and 398 were returned answered. The results of the survey were reported at a recent Section meeting as part of a panel discussion on Engineer Employer-Employee Relationships in the Kansas City area. Members of the Junior Activities Committee are Robert E. Vansant, Allen R. Marsh, James G. Stinson, W. C. Richey, E. C. Balke, and R. C. Bergendoff.

Mexico Section arranges special dinner meeting for ASCE delegation in Mexico City to attend Fourth Convention of UPADI (November issue, page 72). Shown here, in usual order, are Leopoldo Farias S., vice-president, Mexico Section; Miguel Montes de Oca, secretary-treasurer, Mexico Section; Gail A. Hathaway, Past-President ASCE; Enoch R. Needles, then President of ASCE; Lorenzo Perez Castro, president, Mexico Section; William H. Wisely, Executive Secretary of ASCE; W. N. Carey, Secretary Emeritus of ASCE; and Earle S. Sloan, past-president, Mexico Section.

At the helm of the **Maine Section's Vermont Branch** for the coming year are Reginald V. Milbank, president; Reinhold W. Thieme, vice-president; and Stephen C. Knight, Jr., secretary-treasurer. Louis M. Laushey is vice-president for the Section. The new slate was elected at the annual meeting of the Branch, held in Montpelier on November 1. Charles Parker, president of the parent Section, was principal speaker, with an illustrated talk on the construction of the Thule Air Force Base. The **New Hampshire Branch** was a recent host to the Section and its Branches at a dinner meeting at Littleton. The program highlight was a tour of the



Prominent at joint meeting of Philadelphia Section and the American Public Works Association, held early in October, are (left to right) Myron G. Mansfield, senior partner, Morris Knowles, Inc., Pittsburgh, and the featured speaker; Philadelphia Section President Victor G. Thomassen; Frank X. Robinson, president, Philadelphia Chapter, APWA; ASCE Director Oliver Hartwell; Ernest Brooks, secretary, APWA; and Gerald E. Arnold, deputy water commissioner, City of Philadelphia. Mr. Mansfield's talk dealt with the city's Torresdale Filter Plant.

More scenes from the Texas Section's fall meeting, held in Austin on October 4 and 5 (November issue, page 82). Retiring President Walter Porter (right in top photo) turns over the gavel of office to his successor, Prof. Walter L. Moore, of Austin. In view immediately above Ellis Mitchell, of Corsicana, Tex., presents Section's oldest award of merit to Robert J. Potts, of Austin, its oldest living past-president. One of the program highlights was a talk on "The Impact of Peaceful Uses of Atomic Energy" by the Hon. George R. Brown, member of the Joint Congressional Panel on Peaceful Uses of Atomic Energy.

Connecticut Power Company's new 150,000-kw hydroelectric station on the Connecticut River. David Campbell, project design engineer of Ebasco Services, Inc., explained the construction and operating features.

An inspiring program on the National Highway Program with special application to Maryland ushered in the **Maryland Section's** first meeting of the fall season on October 10. The guest speakers were the Hon. George H. Fallon, Congressman from Maryland and author of the all-important Federal Highway Act of 1956 (the Fallon Bill) and John N. Robertson, president of the American Road Builders Association and technical adviser to Congressman Fallon. In his long career in government Congressman Fallon has been responsible for much important road legislation. He is currently acting chairman of the Committee on Public Works and chairman of the Sub-Committee on Roads.

For its October meeting the **Metropolitan Section** responded to popular demand for a repeat performance of a panel-discussion type of program that proved very popular last year. The topic was soils investigations as a necessary preliminary to engineering, planning, and design. The experts, representing three universities, were Professors Joseph S. Ward, of Cooper Union; Donald M. Burmister of Columbia University; and T. William Lambe, of Massachusetts Institute of Technology.

New **North Carolina Section** officers, elected at a meeting held in Charlotte on October 12, are James F. Pou, Charlotte, president; L. E. Wooten and W. F. Babcock, Raleigh, vice-presidents; and C. R. McCullough, Raleigh, secretary-treasurer.

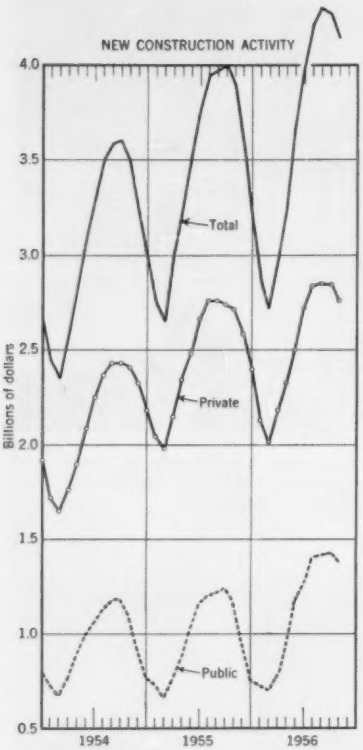
There was a turnout of about 45 members and guests of the **Puerto Rico Section** for a recent meeting co-sponsored by the District Public Works Office of the Tenth Naval District. In the featured talk on "Guided Missiles and Their Influence on Naval Shore-Based Establishments," Retired Rear Admiral Victor W. Buhr outlined the history of rockets from their origin in China, through experiences with the V-1 and V-2 rockets developed in the recent war, to the postwar guided missiles of the "Regulus" and "Sparrow" types. Admiral Buhr is now a member of the Norfolk, Va., firm of Clark, Buhr, and Nexsen, which is currently engaged by the Navy on the design of guided missile facilities at the Naval Station in Puerto Rico.

The **San Diego Section** has voted to support a projected monthly publication of the San Diego Engineering Council. Featured speaker at the Section's September meeting was Capt. A. D. Hunter, civil engineer and public works officer for the Eleventh Naval District, who outlined the District's construction program for 1956–1957.

Members of the **Spokane Section** attending the October meeting heard Carl Dion, member of the H. E. Bovay, Jr., consulting engineering firm, discuss the firm's investigation into the Omak and Goose Lake Water Storage and Power Project.

NEWS BRIEFS . . .

Seasonal Construction Decline Reported for October



Outlays for new construction declined seasonally in October to $4.1 billion, according to preliminary joint estimates of the U. S. Departments of Commerce and Labor. Nevertheless, this figure was slightly above the previous October high set last year.

With the exception of private housing, most major construction categories continued strong. Expenditures for private industrial plants, highways, public utilities, office buildings, sewer and water facilities, churches, and public schools were at an all-time October high. The value of work put in place on new private housing declined more than seasonally to a level 14 percent below the October record of a year ago.

On a seasonally adjusted basis, new construction activity thus far in 1956 has been at rates indicating that this year's total will exceed $44 billion, compared with $43 billion last year. Actual expenditures for the first ten months of 1956 ($37 billion) were 3 percent above the corresponding 1955 figure.

Spending for all types of private construction combined totaled $25.7 billion during the January-October period this year, about the same as the 1955 record for these months. Gains over the year in new non-residential building and utilities construction compensated for the $1.3 billion drop in new private housing.

Public construction outlays during the first ten months of this year ($11.3 billion) were 7 percent above the corresponding 1955 figure, mainly because of sizable increases in highways and in sewer and water facilities, virtually all of which are state and locally owned. Activity on federally owned projects showed a moderate decline this year, as advances in military facilities and conservation and development work failed to offset the decline in construction of installations for the Atomic Energy Commission.

The Federal Government spent almost 20 percent more this year than last for grants-in-aid on state and local construction. However, the proportion of federal funds included in the types of projects which are given federal aid under prevailing statutes—principally school and hospital building and highway work—is still relatively low. During the first ten months of this year, federal grants constituted about 4 percent of total outlays for state and local schools, 7 percent for hospitals, and 15 percent for highways.

Construction activity declines seasonally in October to $4.1 billion—a figure slightly above the previous October high set last year.

Sewerage System Construction Needs Set at $22 Billion

Capital investment of $14.1 billion to increase public sewerage system facilities and expenditures of $8 billion to offset obsolescence will be needed over the next 20 years to provide for adequate service in collecting and treating sewage for the expanding population of the United States, according to the Water and Sewerage Industry and Utilities Division of the Business and Defense Services Administration, U. S. Department of Commerce. Present capital investment in public sewerage system facilities is estimated at $19.9 billion in the "Summary of Information on Public Sewerage Systems—Capital Investment Values," recently issued by the Division. The required capital outlays would increase this figure to $34 billion by the end of 1975.

Information collected by the Division from all available sources indicates many inadequacies in facilities, particularly in sewage-treatment plants needed to meet present standards of treatment to abate stream pollution. To provide fully for adequate collection and treatment would require an estimated expenditure of $5.8 billion. Further expenditures of $8.3 billion will be required over the 20-year period to expand these public sewerage facilities to an extent estimated sufficient to serve the population growth with its increased rate of water usage, and to maintain appropriate control of stream pollution.

The Division's estimates are based upon an anticipated increase in the population of the United States from about 164.6 million in 1955 to 206.6 million in 1975. Copies of the summary, priced at 10 cents each, are available from the Department of Commerce, Washington 25, D. C.

Engineer Shortage Reported Increasing

Despite the graduation of 30,000 engineers last year, the backlog of engineering vacancies at local public employment offices rose substantially during the year, according to the Labor Department's Bureau of Employment Security. In August, the Bureau reports, local public employment offices had 6,400 engineering vacancies, for which they were seeking applicants through intensified out-of-area recruitment. This compared with 4,200 such vacancies in August a year ago.

The backlog of job orders for engineers increased steadily from early 1954 to May of this year, when vacancies listed with the employment service reached the record postwar high of 6,700. As June engineering graduates entered the labor market, the number of vacancies dropped to 6,100 in July, but moved up to 6,400 in August.

AISC Awards Prizes for Beautiful Bridges Opened to Traffic in 1955

Upper view shows Missouri River Bridge at Leavenworth, Kans., winner in Class I for bridges with spans of 400 ft or more. Right-hand photo depicts Ohio Turnpike Bridge over Cuyahoga River, winner in Class II, for bridges with spans under 400 ft costing over $500,000.

Sixteen bridges in ten states have been chosen from 80 entries as the most beautiful bridges in the country opened to traffic in 1955, in the American Institute of Steel Construction's 28th Annual Aesthetic Bridge Competition. Stainless steel plaques will be affixed to the top winners in four classes, and Honorable Mention Certificates go to the remaining twelve.

Top honors go to four structures. The winner in Class I, for bridges with spans of 400 ft or more, is the Missouri River Bridge at Leavenworth, Kans., which was chosen for the highest award in its class "because the clean, simple, repetitive design gives a feeling of gracefulness to the double arch." The structure was designed by Howard, Needles, Tammen & Bergendoff. The arch spans were fabricated by the Kansas City Structural Steel Company, and the approach spans by Missouri Valley Steel, Inc. The owners are the city and the Kansas and Missouri State Highway Commissions.

In Class II, for bridges with spans under 400 ft, costing over $500,000, top honors go to the Ohio Turnpike Bridge over the Cuyahoga River, which was designed by the J. E. Greiner Company and fabricated by the Bethlehem Steel Company. The jury stated that it, "Liked the unusual design of the two separate roadways because of the interesting use of materials in juxtaposition."

Old State Route 8 Bridge, over Ohio Turnpike No. 1, southeast of Cleveland, is the winning entry in Class III for bridges with fixed spans under 400 ft, costing less than $500,000. Howard, Needles, Tammen & Bergendoff was the designer, and Allied Structural Steel Companies the fabricator. In the opinion of the jury, "The simple arch, springing from rock abutment to rock abutment, is a masterful expression of truth, character and beauty."

The winner in Class IV, for movable span bridges, is the Welfare Island Bridge, spanning the East River from Queens to Welfare Island. New York City owns the structure, which was designed by Tippetts - Abbett - McCarthy - Stratton, and fabricated by the Harris Structural Steel Co. The jury applauded the "rounded treatment of the towers . . ."

Honorable Mentions, in Class I, have been awarded to the Jefferson City-Missouri River Bridge, designed by Sverdrup & Parcel, Inc.; the Fort Henry Bridge over the Ohio at Wheeling, W.Va., designed by Howard, Needles, Tammen & Bergendoff; the Tappan Zee Bridge across the Hudson between Tarrytown and Grandview, designed by Madigan-Hyland; and the Barnhart Island Bridge designed by Praeger-Kavanagh.

Winners of Honorable Mention in Class II are the Cattaragus Creek Bridge at Springville, N.Y., designed by the New York State Department of Public Works; the Queens Boulevard Bridge of the Long Island Expressway, designed by Ammann & Whitney–Clarence C. Combs; the Distribution Structure Overhead Addition at Oakland, Calif., designed by the California Division of Highways; and the Colorado River Bridge at Moab, Utah, designed by Woodruff & Sampson.

Honorable Mentions in Class III go to the Snake River Bridge near Alpine, Wyo., designed by the Bureau of Reclamation; the Archibald Avenue Bridge, Riverside County Line, California, designed by the Bridge Department of the California Division of Highways; the Blue Bridge over Johnson Street, Cumberland, Md., designed by the Maryland State Roads Commission; and the Hoover Dam Bridge in Franklin County, Ohio, designed by K. E. Dumbauld.

Top honors in Class III, for bridges with fixed spans costing less than $500,000, go to Old State Route 8 Bridge (at left) over Ohio Turnpike. In Class IV, for movable span bridges, winner is Welfare Island Bridge (at right), spanning East River from Queens to Welfare Island.

Jochenstein hydro project on Danube River has twin locks on right (Bavarian) side. Power plant (center) has five units yielding 920 million kwhr annually. Locks have usable length of 755 ft, and are closed upstream by sluice gates and downstream by miter gates. Head bay is 1,640 ft long and 328 ft wide.

Germany and Austria Build Danube Hydro Plant

In a joint effort, Germany and Austria have recently completed a power plant downstream of the German city of Passau on the Danube, where that river forms the border between Bavaria and Austria. This hydro plant, Jochenstein, has been equipped with five generating units yielding a power output of 920 million kwhr annually. The energy thus produced is fed into the grids of the two border states and shared equally between them.

The preparatory work was carried out jointly and the cost of materials, supplies and erection were borne by both parties. Construction work was done by the Donaukraftwerk Jochenstein A.G., an intergovernmental company of the two neighboring states. Jochenstein is the first of the 14 development stages envisaged along the Austrian Danube, of which only Ybbs-Persenbeug is at present under construction.

The powerhouse is designed for an overall turbine intake of 61,500 cfs. Five Kaplan turbines have been installed, each with a capacity of 39,400 hp and an absorption capacity of 12,300 cfs. The net head amounts to 31 ft 6 in. The turbines are directly connected to synchronous generators of 35,000 kva and 9,000 kv each. On the platform five transformers of 35,000 kva each (9 phase at 220 kv) have been mounted.

The weir consists of six openings with a free width of 78 ft 8 in. each, separated by pillars. They may be closed by double hooked sluices and by stop-logs. The stoplogs of the weir openings as well as those of the locks and the powerhouse are operated by a floating crane of about 100-ton capacity.

The powerhouse is connected with the left river bank by two bridges, and there is a walkway over the weir pillars.

The backwater basin, 18.6 miles long, required the construction of extensive revetment masonry. To increase the available head, the tailwater was deepened by some 3 ft 11 in. over a distance of about 4.3 miles.

During the whole construction period, uninterrupted navigation had to be maintained. For this reason the work was carried on successfully in four construction pits.

Among the difficulties encountered in building this plant were the flood flows of July 1954, the worst that had occurred in 45 years. Other difficulties were caused by the catastrophic ice formation which occurred in January and February 1956. Both of these natural catastrophies were overcome without great loss and damage to the installations.

Construction work, which began in 1952, was completed in a relatively short time. On April 1, 1955, partial storage was initiated. On July 1, 1955, the first three generating units, and in August 1956 the remaining two generating units, were put in operation.

(The information on which this item is based was supplied by Dr. Erwin Konigshofer, engineer of Vienna.)

Ohio Turnpike Story

The detailed story of the $326,000,000 Ohio Turnpike—from legislation to operation—is told in the *Ohio Turnpike Report*, which has just been released by Ohio State University as one of its Engineering Monograph Series. Theodore J. Kauer, M. ASCE, chief engineer for the Ohio Turnpike Commission from 1952 to 1956, is the author. The 150-page report includes material of interest to contractors, law enforcement and safety officials, and lawyers, as well as detailed technical information.

Copies, priced at $6.00 each, are available from the University Press, Ohio State University, Columbus 10, Ohio.

Moles Announce Their New Award Winners

Guy F. Atkinson, M. ASCE, of San Francisco, and Louis R. Perini, of Framingham, Mass., have been named as the 1957 recipients of the awards given annually by the Moles, New York society of heavy construction men, for "outstanding achievement in construction." They are the seventeenth pair of winners in a series that started in 1941 and included former President Herbert Hoover, Robert Moses, Admiral Ben Moreell, the late Gen. Brehon B. Somervel, Peter Kiewit, and Harvey Slocum.

The award, which is considered the highest honor in the American construction industry, is given annually to one member of the Moles and one non-member. The new awards will be presented at the annual Moles Awards Dinner, to be held at the Waldorf-Astoria on February 7.

Mr. Perini, the member winner, is president of B. Perini & Sons, a company that has figured in many of the largest tunnel and dam jobs in the East in the past twenty years. He is also president of the Milwaukee Braves baseball team, and a past-president of the New England Road Builders Association.

Mr. Atkinson is board chairman of the Guy F. Atkinson Company, which has performed more than a hundred major contracts in this country and overseas, including Grand Coulee Dam, McNary Dam and Powerhouse, and the atomic energy plants at Hanford, Wash. He is a past-president of the Associated General Contractors of America.

Guy Atkinson Louis Perini

Economic Limits of Truck Weight Explored

Three phases of investigation into the economic factors affecting future size and weight specifications for highway freight vehicles were reported at a meeting of the Highway Research Board's Committee on Economics of Motor Vehicle Size and Weight, held in Washington on October 11.

One phase of the study, which is being conducted in several states outside city delivery areas, is concerned with determining operating costs of different types of freight vehicles with different load capacities. The aim of this part of the study is to establish the degree to which unit costs of transporting freight are reduced as gross vehicle weight allowances are increased. It is expected that the study also will reveal the point of diminishing returns in so far as gross weights of freight vehicles are concerned.

For the second phase of the study, which deals with highway transportation demands in terms of weight, there was explained a new way of handling published statistics relative to transportation of commodities. The third phase of the investigation is exploring methods of developing costs of constructing and maintaining highways for different levels of gross vehicle weights. The preparation of a schedule of gross vehicle weights, with accompanying vehicle types and axle weights in the range of those planned for in the AASHO Road Test, was approved. It is believed that from such a schedule it may be possible to develop national trends showing how highway costs increase with increasing levels of gross vehicle weights.

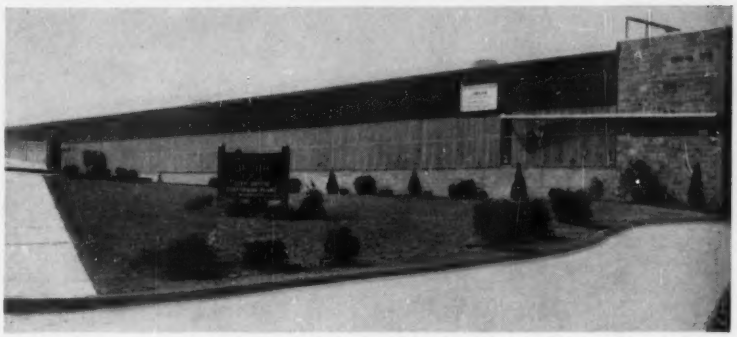
The committee is made up of representatives of motor carriers, truck and trailer manufacturers, state highway departments, Bureau of Public Roads engineers, and other interested groups. Chairman and secretary of the committee are Carl C. Saal and Hoy Stevens, both of the Bureau of Public Roads.

Tennessee Plans 65-Mile System of Expressways

The Tennessee Department of Highways has awarded a contract to Harland Bartholomew & Associates, St. Louis city planning firm, to make a preliminary engineering report and prepare plans and specifications for some 15 miles of expressway, to be constructed in the Memphis area of Shelby County. Clark & Daily, of Urbana, Ill., to be associated with the St. Louis firm in carrying out the contract for the Tennessee Highway Department, will have primary responsibility for the structural design of bridges and culverts.

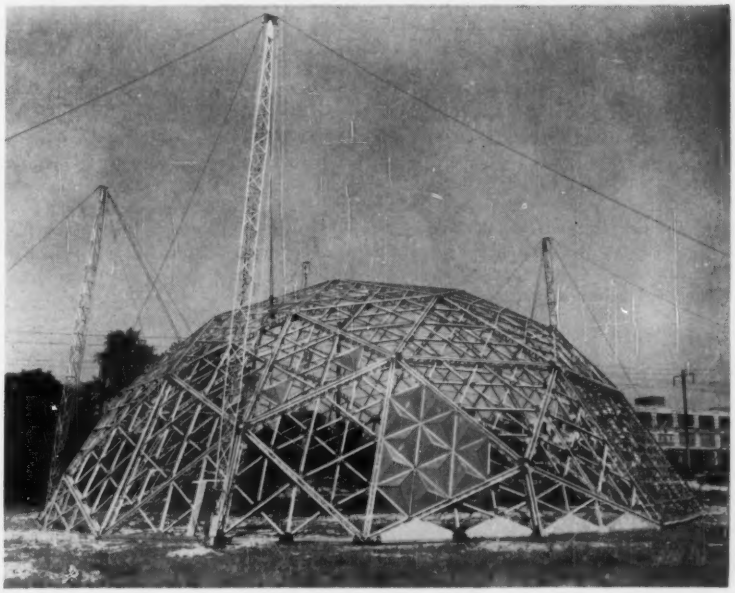
Harland Bartholomew & Associates is opening an office in Memphis to expedite completion of plans for the 15-mile, $15,000,000 expressway section, which will be part of a projected 65-mile interstate highway system planned for the area.

Factory Converts Garbage Into Fertilizer



This new Orcoa plant at McKeesport, Pa.—erected and operated under contract by the Organic Corporation of America, Pittsburgh—houses a process that takes the city's entire accumulation of raw garbage, trash, and waste and transforms it into rich organic fertilizer. The operation, which takes from 14 to 21 days, eliminates the double work of collecting garbage and trash and separating it. All material is pulverized in grinders, and rapidly decomposed by injection of special enzymes. The entire operation is odorless and smokeless and involves no residue. Developed by the H. G. Burr Company, the Orcoa process is the result of over four years' research and experiment.

Portable Plastic Dome Features Quick Disassembly



This 117-ft plastic geodesic dome features quick, easy disassembly for transport by plane. Fabricated and erected by the Washington Aluminum Company on its Baltimore premises (where it is shown), the dome was later disassembled for delivery by airplane to the U. S. Marine Corps for prototype functional testing as a portable aircraft hangar or repair shop. It stands 46 ft high and is 117 ft across at the base. The covering includes 1,112 fiberglas pyramids, some of which are shown in place. The "clearspan" dome has no supports except for the shell. The ginpoles surrounding it are part of the erection equipment and are removed when the dome is completely assembled. The dome breaks down into 80 major triangles, which in turn break down into three leg trusses, about 22 ft long, plus a number of extruded members that receive the plastic skin. The dome was designed by R. Buckminster Fuller.

Giant Machine Sorts Stone for Rock-fill Dam in Colorado

Nearly three-quarters of a million cubic yards of rock is required in construction of Montgomery Dam, which will augment the Colorado Springs water supply by 18 mgd. Two ten-hour shifts and an unusual machine that sorts stone are at work two miles up in the air on this $2,300,000 project, which will impound runoff from the Blue River Project, diverted through the Continental Divide. From Montgomery Reservoir the water will run through a 75-mile-long, 30-in. pipe to city reservoirs in the Pikes Peak area. Located six miles south of Alma, Colo., at an altitude of 10,700 ft, Montgomery Dam will be the highest in the country in point of elevation. It is a rock-fill structure with waterproof membrane of asphaltic concrete—first of its kind to be built in the United States. To ensure the porous toe required for proper drainage, the contractor is using a "Wobbler" feeder to sort fines from oversize rock. A product of the Universal Engineering Corp., Cedar Rapids, Iowa, the feeder was originally developed for heavy-duty screening in taconite mining. A set of bars on the bottom of a hopper give a rocking tumbling motion to the quarry material dumped on them. The bars are oval in cross section and set alternately vertical and horizontal. They maintain the same relative positions as they turn. The effect is a thorough churning that separates the fines which fall through the bars and are carried away on a belt. The oversize material is chuted into trucks and carried to the dam. The wobbler handles nearly 500 tons an hour, rejecting material under $^3/_4$ in. The Fisher Contracting Company, Phoenix, Ariz., is the contractor.

International Irrigation Congress to Meet in U.S.

Delegates of 34 member countries of the International Commission on Irrigation and Drainage will assemble in San Francisco next spring for the Commission's Third Congress—the first to be held in the United States. Previous congresses were in India in 1951 and in Algeria in 1954.

The United States National Committee will be host to the San Francisco Congress, which will meet in the Sheraton-Palace Hotel, April 29–May 4. Walter E. Blomgren, Denver consultant, is chairman of the committee, and Prof. Frederick L. Hotes, of the University of California at Berkeley, is chairman of the San Francisco committee making local arrangements.

A large attendance is expected because of growing concern with water problems. The program will cover papers on four topics: canal linings; soil-water relationship in irrigation; hydraulic structures on irrigation and drainage systems; and the interrelation between irrigation and drainage. New practices, equipment, and machinery will be on exhibit during the week-long program. Two weeks of study tours will follow the technical meeting, giving visitors the opportunity to see both private and public water developments in the United States and the plants that manufacture irrigation equipment.

Information about the Third Congress may be obtained from the United States National Committee, International Commission on Irrigation and Drainage, Post Office Box 7826, Denver 15, Colo.

Protection for Engineer's Plans

A Superior Court jury in Los Angeles County recently awarded damages of $50,000 to Bent H. Cardan, structural engineer and general contractor of West Hollywood, Calif., whose building plans and specifications were illegally copied and used without authority. The award is said to be unprecedented in California records, and the first time that plans and specifications, developed over many years by an engineer and general contractor, have been accorded the respect due copyrights and patents.

The defendants were Murray Stern, owner of the apartment house built from the plans and specifications; the Green Brothers Construction Co.; and J. B. Dodge, draftsman.

Building Code for Midwest

A new building code designed to meet requirements and climatic conditions of the Midwest States will be issued early in 1957. The Midwest Conference of Building Officials, with headquarters in Indianapolis, is the sponsoring organization. In announcing the code, Executive Director John V. Gallagher stated that it will be available to cities and communities of the Midwest states for adoption around January 1.

The new code, which will be identified as "Volume I, Midwest Building Code," will contain provisions regulating the construction of buildings of all types and occupancies based on minimum requirements. It will be simple in form, assuring ease of administration.

New Facilities for AEC's Nevada Test Site

Holmes & Narver, a consulting firm with headquarters in Los Angeles, has been designated by the Atomic Energy Commission as architect-engineer for major test facilities at the Commission's Nevada Test Site. The contract will include design and supervision of construction of facilities, such as towers, bunkers, instrumentation stations and the like. Since 1948 Holmes & Narver has been the principal contractor for the AEC's Eniwetok Proving Ground in the Pacific, where it has designed and built more than $25,000,000 worth of permanent improvements in addition to test structures.

The Burns & McDonnell Engineering Co., of Kansas City, Mo., is architect-engineer for the new technical area at the test site, and the Reynolds Electric & Engineering Company will continue as architect-engineer for permanent base facilities there.

Record-Size Lift Slab Raised on New Jersey Project

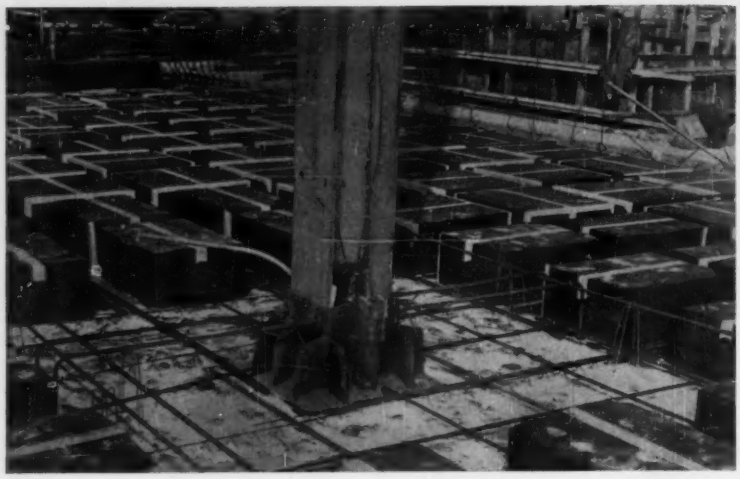


Photo shows a column with cast-steel lifting collar in place. Completed slab was raised to tops of columns by 24 lifting jacks powering threaded rods connected with collars.

Recent construction of a concrete roof for a one-story plant of the Standard Tool and Manufacturing Co. at Lyndhurst, N. J., was expedited by use of the lift-slab method. The roof was cast on the floor slab and lifted into position 26 ft above grade. The middle and largest of the three slabs comprising the roof is 216 ft long by 150 ft wide—three-quarters of an acre in area—and weighs 1,400 tons. It is said to be the largest and heaviest lift slab ever raised.

Corrugated fiber-board boxes formed the waffle-like underside of the slab, which is 16 in. deep. Lightweight concrete, weighing 108 lb per cu ft and with an average strength of 3,500 psi, was made of Lelite-expanded shale aggregate with plastiment as the admixture. The record-size slab was lifted by hydraulic jacks mounted on top of 24 columns spaced on 40-ft centers. Lifting was regulated from two control consoles.

Powers and Kessler were the architects, and Garfinkel and Warenberg (both of New York) the consulting engineers. Fred J. Brotherton, Inc., was the general contractor, and the New England Lift-Slab Corp., raised the slabs.

N * COLUMN

R ROBINSON ROWE, M. ASCE

"I have a couple of questions," announced Joe Kerr.

"I ask the questions around here," blurted Professor Neare. "You'd better have the answers, or hush."

"I won't hush, but I'll change my questions to interpretations of your question and let you call me wrong if I am."

"I asked for a triangle with integral sides and an area of an acre; how could you misinterpret that?"

"Well, you asked for a better shape than 88 × 1122 × 1166 ft. Also, it was located in Heron Acres, which sounds like a subdivision of a swamp. In a swamp, I'd like a shallow lot with long frontage on the highway, like one 109 × 1341 × 1430."

"That's a nice one for a one-hole golf course," conceded the Professor, "But Heron Acres isn't a swamp. It's. . ."

"Let me tell him," begged Al E. Dayde. "To a surveyor like me, Heron was the chap who made surveying a profession 2000 years ago. His dioptra anticipated my transit and his formula

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

is still the best for computing the area of a triangle from its sides."

"And," added Cal Klater, "triangles with rational sides are called Heron triangles, because he was the first to write of them. For your problem, $A = 43{,}560$ and you ask for integers a, b, c. If we let $a = x + y$, $b = y + z$ and $c = z + x$, where x, y and z are the semi-tangents to the inscribed circle, the Heron formula becomes $A =$

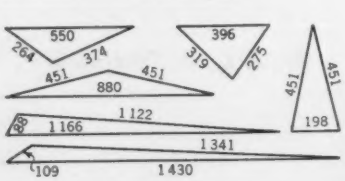
$$\sqrt{xyz(x+y+z)} = 43{,}560.$$

Solving for x:

$$2x = \sqrt{(y+z)^2 + 87{,}120^2/yz} - (y+z)$$

which reduces the complete problem to that of finding values of y and z to make the quantity under the radical a perfect square. The sets 10,99 and 22,66 give the sliver lots already described. New sets 11,440 and 99,99 give the isosceles and 44,220 and 99,176 the scalene lots shown in Fig. 1. I like the 275 × 319 × 396-ft lot the best."

Fig. 1. Heron acres may be scalene or isosceles, but none are right.



"I don't blame you," agreed the Professor. "At least it takes the least fencing."

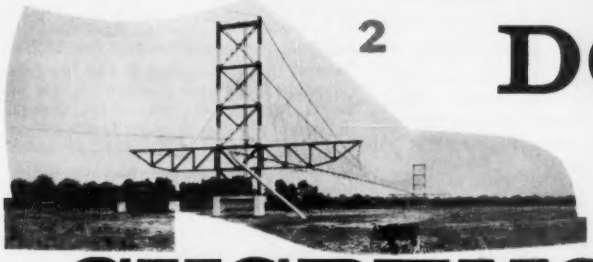
"But not the least surveying," complained Al. "I'm going to make 198 × 880-ft blocks in Heron Acres and set stakes at the corners and center. Then the 5 stakes will give me 4 isosceles acre lots. That's efficiency!"

"Every man to his own business," ruled the Professor. "I was hoping for a larger block for our next problem, but the situation really developed in an older subdivision that was already built up.

"In this older subdivision, there are 5 houses between Ames and Barr; Case lives in the middle one. There are 2 houses between Barr and Dunn and 3 between Ames and East. Farr is as far from Dunn as he is from Ames. Barr lives in the 5th house east of East. Who lives farthest from whom?"

[Kerrs, Klaters, and Daydes were Flo Ridan (Charles G. Edson), Ad L. Pate (G. H. Wilsey), Richard Jenney, H. Francis Finch, Emerson Boyd Jr., Donald E. Milks, Al Gorithm (L. E. Goodman and A. R. Robinson), Thatchrite (Guy C. Thatcher) Kum Pewter (Walter Steinbruch), and Julian Hinds. R. M. Carmany and W. I. Stemwell also solved the September problem.]

WHAT SIZE



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Whatever you contemplate; overhead support of material conveyors, of pipes, or of power lines; moving men from one plant point to another or crossing a ravine to the 16th tee, you will do well to take advantage of Roebling's vast experience in suspension systems of all types.

Our facilities, in the creative as well as the material sense, are at your disposal. Write to Bridge Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

1 *The San Marcos Highway Bridge in El Salvador, Central America. It is the first application to a major highway crossing of the Roebling-developed Cable Stiffened Suspension Bridge. Designed and erected by Roebling.*

2 *A pipeline bridge that carries natural gas across the Brazos River in Texas. Designed by Mathews and Kenan, Consulting Engineers; erected by Pittsburgh-Des Moines Steel Company.*

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DECEASED

Robert Usher Andrews (M. '56), age 65, sanitary engineer for the City of Fort Worth, Tex., died at his home there recently. Mr. Andrews had been in responsible charge of the city's Sewage Collection System since 1927. During this 29-year period, the mileage in the system grew from 290.2 miles to its present 1176.3 miles. Earlier Mr. Andrews was party chief, main inspector, and engineer in charge of water filter plant enlargement for the city. He studied civil engineering at the University of Texas and was a World War I veteran.

Thomas A. Berrigan (M. '42), age 61, engineer and lawyer of Boston, Mass., died at his home in Westwood, Mass., recently.

T. A. Berrigan

Mr. Berrigan retired last year after 20 years as director and chief engineer of the Boston Metropolitan Sewerage Works to open an office for the practice of law and engineering. He was senior engineer for the Boston Transit Department from 1925 to 1934. Mr. Berrigan was a graduate of Massachusetts Institute of Technology, class of 1916, and received his law degree from Northeastern in 1930. He also served as chairman of the Merrimack Valley Sewerage Board of Boston.

Francis Rigdon Berry (M. '30), age 75, retired assistant chief engineer with the American Water Works and Electric Co. of New York City, died recently at his home at Cocoa, Fla. Mr. Berry was associated with his company from 1914 until his retirement in 1948, and was in responsible charge of the engineering department of the waterworks division.

Hans Christie (M. '24), age 83, retired structural engineer with the Columbia Steel Company, Los Angeles, Calif., died at his home there recently. Mr. Christie was a civil engineering graduate of Trondhjem Technical College, and had an advanced degree from Zurich Polytechnic Institute. After seven years with Norwegian State Highways he came to the United States. From 1904 to 1909 he was erection engineer for Milliken Brothers, of New York, on projects in the United States, Mexico, South America, and Japan, and from 1909 to 1927 he supervised field erection and design of erection equipment for the American Bridge Company in Pittsburgh. His specialty was transmission towers, and he was co-author of an American Bridge Company book on the subject. Mr. Christie joined Columbia Steel in 1927 and retired in 1940.

Frederick B. Duis (M. '11), age 85, retired principal engineer with the U. S. Engineer Office in Cincinnati, Ohio, died at his home there recently. Mr. Duis was with the U. S. Engineer Office from 1905 until his retirement in 1940. He had been assistant engineer and principal engineer on design, construction, operation and maintenance of locks and dams and channel improvements.

Jack Jones Hinman, Jr. (M. '31), age 68, Colonel, U. S. Army Corps of Engineers (retired), died at his home in Iowa City, Iowa, recently. He was a 1911 graduate of Butler University, and received a civil engineering degree from the University of Iowa in 1937. For a number of years he was on the faculty of the University of Iowa, where he was assistant director of the state Epidemiological Laboratories and associate professor and chief, Water Laboratories Division. Long an officer in the Iowa National Guard, he was inducted in World War II as chemical officer of the Chemical Warfare Service, with the rank of Lieutenant Colonel, and stationed at Fort Belvoir.

John Jacob Konrad (M. '55), age 49, since 1946 chief of the Construction Division of the Army Corps of Engineers, Huntington (W. Va.) District, died at his home at Huntington recently. A graduate of West Virginia University, class of 1930, Mr. Konrad had spent his career in the Corps of Engineers, which he joined shortly after his graduation. He had been resident engineer and chief of several sections, and had worked on the Bluestone Flood Control Dam, Parkersburg Flood Wall, Dewey Flood Control Dam and the Portsmouth, Ohio, Flood Wall.

Edmond Alston McNatt (A.M. '44), age 47, chief engineer of Turnpike Engineers, Arlington, Tex., died at his home there recently. Before joining Turnpike Engineers two years ago, Mr. McNatt was for seven years airport engineer with the Civil Aeronautics Administration at Fort Worth, Tex. Earlier (1937 to 1947) he was highway engineer with the Public Roads Administration (now the Bureau of Public Roads) in Washington, D. C. His assignments with the PRA included conducting transportation and highway economic studies of six Latin American countries to aid the United States in formulating its highway policy for other countries of the Western Hemisphere. He was a civil engineering graduate of the University of Texas, class of 1931.

Leopold J. Mensch (M. '05), age 80, civil engineer and contractor of Evanston, Ill., died at his home there recently. A graduate of the Imperial Technical College of Vienna in 1894, Mr. Mensch worked on the design of steel and reinforced concrete for buildings, suspension and arch bridges, and viaducts in Vienna and England. From 1900 to 1947 he had a civil engineering and contracting practice in Chicago, Ill., specializing in reinforced concrete work. He contributed many technical papers in the structural design field to ASCE Technical Publications.

Henry L. Moeller (M. '17), age 70, vice-president and chief engineer of the Jarka Corp. of New York City, died at his home in Millburn, N. J., recently. A graduate of Cornell University, class of 1907, Mr. Moeller was an engineer with the Martini & Huneke Co. of America for 14 years—first in Europe and later as chief engineer in New York on the design of safe storage and distribution of inflammable liquids. He was chief engineer for the Mercur Corporation, Port Newark, N. J., from 1928 to 1938, joining the Jarka Corp. in the same capacity in the latter year. Mr. Moeller was a retired Brigadier General in the New Jersey National Guard, and during World War II served as Inspector General of all New Jersey units.

John W. Oehmann (M. '26), age 73, Brigadier General, U. S. Army (retired) and inspector of buildings for the District of Columbia from 1924 to 1946, died recently at his home at Ormond Beach, Fla. General Oehmann served in the Mexican campaign and was a munitions officer in World War I. He was made deputy building inspector in 1919 and building inspector five years later. In 1941 he was called to active service with the 121st Engineers, which he commanded in England for one year. After serving in the United States for two years, he resumed his duties as building inspector in 1944. He was said to have handled $400 million in District construction.

Alger E. Rush (M. '41), age 57, for the past two years associate in the engineering and architectural firm of Nielsen and Rush, Inc., of Nashville, Tenn., died at his home there recently. For nineteen years prior to this association, Mr. Rush was with the Tennessee Valley Authority as associate engineer, highway engineer and construction superintendent in the highway and railroad divisions. Earlier, he was with the North Carolina Highway Commission for eleven years. Mr. Rush received his civil engineering degree from Clemson College in 1920.

Donald J. Sadar (J.M. '52), age 25, Corporal, U. S. Army Corps of Engineers, died at Fort McClellan, Ala., on October 13 after a brief illness. A native of Denver, Colo., he received a B. S. degree in civil engineering in 1952 and a M. S. degree in irrigation engineering in 1955 from Colorado A & M College. He joined the army in 1954 and since 1955 had been assigned to the Waterways Experiment Station at Vicksburg, Miss. Prior to entering the service, he was an engineer with the Agricultural Research Service at Fort Collins, Colo.

James Henry Knowles (M. '19), age 80, retired division engineer of the San

(Continued on page 100)

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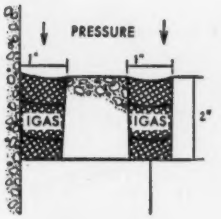
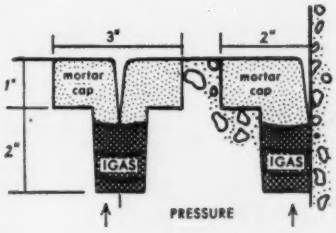
TYPE A—Face Pressure

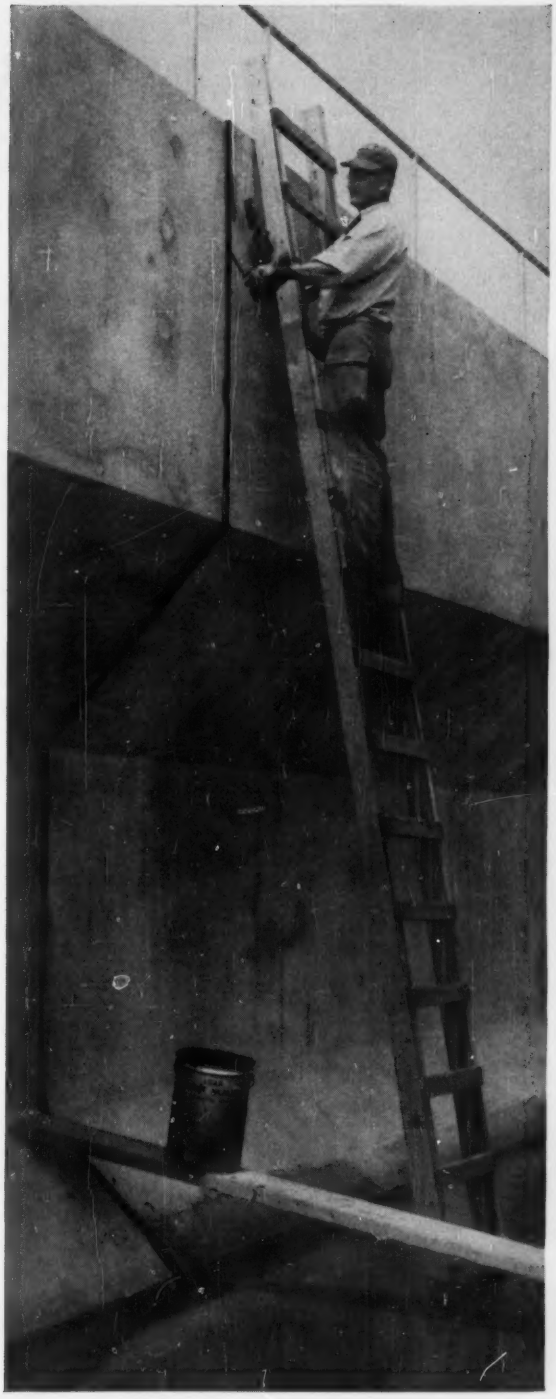


Water Reservoirs
Swimming Pools
Tanks
Parking Decks

TYPE B—Back Pressure

Basements
Tunnels
Retaining Walls





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Deceased

(*Continued from page 98*)

Antonio (Tex.) Division of the Southern Pacific Railroad, died there recently. A graduate of the University of Wisconsin in 1899, Mr. Knowles spent several years with the U. S. Coast and Geodetic Survey in Alaska and the Western States. His 30 year career in the railroad field was spent as an engineer mainly with the Southern Pacific Railroad and the Western Pacific. Mr. Knowles retired in 1945.

Roy Stanley Swinton (M. '36), age 70 for more than thirty years on the faculty of the University of Michigan, died suddenly on October 20 in Jakarta, Indonesia, where he was a member of a University of Kentucky team working on contract with the University of Indonesia. He was on terminal leave from the University, where he was associate professor of engineering mechanics. Professor Swinton was well known in American and Far Eastern educational circles and, as a young engineer, planned the first engineering courses for the University of the Philippines. He had been in charge of construction of foundations for the Lincoln Memorial in Washington.

Vernon Gregg Watters (A.M. '13), age 70, retired vice-president of Consolidated Naval Stores Co., Sebring, Fla., died there recently. An engineering graduate of Iowa State College, class of 1907, Mr. Watters subsequently became a junior engineer in the Corps of Engineers Office at Jacksonville, and later worked on construction of the Panama Canal. He had been engineer and vice-president of the Savannah River Lumber Co., at Savannah, Ga., and from 1933 until his retirement in 1943 was on the executive staff of Consolidated Naval Stores Co.

Abraham Underhill Whitson (A.M. '06), age 78, civil engineer and surveyor of Flushing, N. Y., died at his home there recently. He was a graduate of Cornell University, receiving his civil engineering degree in 1899. Early in his career Mr. Whitson was associated with the Flushing Department of Parks. For the past 40 years he had a surveying firm in Queens, N. Y., and was city surveyor of Flushing.

Lloyd Otto Zapp (M. '53), age 42, senior supervising civil engineer with the Humble Oil & Refining Co., Houston, Tex., died there on October 17. Mr. Zapp was a civil engineering graduate of Texas Agricultural & Mechanical College, class of 1934, and shortly thereafter joined the Humble Oil & Refining Co. In World War II Mr. Zapp served in Europe as Battalion Commander in the U. S. Army Engineers. He returned to Humble Oil in 1946 as supervising civil engineer.

RECENT BOOKS

(added to the Engineering Societies Library)

Architectural Graphic Standards

This reference volume by Charles George Ramsey and Harold Reeve Sleeper for architects, builders, civil engineers, and others interested in building gives the standards and facts needed to deal with a wide range of types and phases of construction. The new edition has been thoroughly revised, and it has been rearranged into twenty-three sections covering such topics as foundations; wood, steel, concrete, and masonry construction; hardware; interior finishes; mechanical equipment; and landscaping. (Fifth edition, 1956. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, 758 pp., $18.50.)

Architectural Refresher for Professional Engineers' License

This booklet by J. D. Constance and F. J. Ferrucci contains sketches illustrating typical answers to questions that have been asked in past years in the architectural section of Part I, Structural Planning and Design, of the New York State Examinations for professional engineers. Layouts of warehouses, garages, shopping centers, private houses, industrial buildings, etc., are included. (John D. Constance, 625 Hudson Terrace, Cliffside Park, N.J., 1956. 25 p., $2.50.)

ASTM Standards on Mineral Aggregates and Concrete

This compilation includes the latest specifications and methods of tests for crushed stone, crushed slag, gravel, and light weight aggregates; ready mixed concrete; air entraining admixtures; brick and block pavement materials; concrete curing material; expansion joint fillers; cement; and concrete reinforcing steel. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1956. 302 pp., $3.75.)

Atmospheric Pollution, Its Origins and Preventions

This is a general approach to the subject, intended to provide engineers, public health officials and other interested readers with a foundation for more technical studies. It includes discussion of fuels, fuel burning appliances, and industrial processes as sources of pollution, as well as information on measurement, distribution, effects, and remedial measures. This edition includes a new chapter covering pollution in fogs, pollution from nuclear reactions, and recent trends in Great Britain. A bibliography has also been added. A. R. Meetham is the author. (Pergamon Press, Inc., 123 East 55th St., New York 36, 1956. 302 pp., $11.00.)

Bibliographic Survey of Corrosion 1952–1953

Summaries of over 3000 references on corrosion and corrosion prevention are arranged in the following main groups: general, testing, characteristic phenomena, corrosive environments, preventive measures, materials of construction, equipment, and industries. The references are indexed by subjects and by authors. An appendix has been included to aid the user in locating and obtaining copies of foreign or domestic journals or articles. (Published by National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Tex., 1956. 382 pp., $12.50.)

Chambres D'Équilibre

Part I of this mathematical treatment of hydroelectric plant surge tanks analyzes the effect of various conditions such as the dimensions of the upstream reservoir, the angle of the surge tank riser, etc. In Part II a method of rapid calculations is developed based on "relative values," expressing by a few parameters the coordinated variables of similar systems. The graphical as well as the analytical representation of the method is given. The author is André Gardel. (F. Rouge & Cie., Lausanne, Switzerland. 1956. 158 pp., Sw. Frs. 24.85.)

Computers; Their Operation and Applications

Basic information is presented on the elements, reliability, maintenance, advantages, and limitations of analog and digital computers, including large-scale and miniature types. A fairly extensive section on applications gives brief notes on a wide range of actual and potential, business, military, and other uses of computers. The authors are Edmund C. Berkeley and Lawrence Wainwright. (Reinhold Publishing Company, 430 Park Ave., New York 22, N. Y. 366 pp., bound $8.00.)

Colloquium on Fatigue. (International Union of Theoretical and Applied Mechanics, Stockholm, 1955.)

The present volume edited by W. Weibull and F. K. G. Odqvist contains the thirty-five papers presented at the Colloqium in full, with discussions. Among the topics dealt with are statistical theory of fatigue, cumulative damage, mechanism of fatigue, velocity of fatigue cracks, fatigue at elevated temperatures, and fatigue at combined stresses. About half the papers are in English, the remainder in French or German. The subject index is given in all three languages. (Springer-Verlag, Berlin. 1956. 339 pp. bound. DM 46.50.)

Decken aus Fertigbauteilen

The two reports by Otto Graf and Gustav Weil contained in this publication present the results of full-scale tests on floors of pre-cast structural parts: 1. Tests of the bond between pre-cast reinforced concrete beams and the concrete cast in place four weeks later. 2. Tests on light steel girders for reinforced-concrete floors. (Deutscher Ausschuss für Stahlbeton, Heft 119. 1955, Wilhelm Ernst & Sohn, Berlin. 1955. 36 pp. DM 10.40.)

Die Cross-Methode und Ihre Praktische Anwendung

This treatise on the Hardy Cross method of structural analysis by Richard Guldan is presented in three parts: fundamental information needed for a thorough understanding of the method and its application; thirty-four specific examples worked out in detail, of practical applications dealing with buildings and bridge structures; 117 pages of tables and graphs for ready reference. (Springer-Verlag, Wien. 1955. 422 pp., $17.15.)

(*Continued on page 102*)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translations services, and can supply photoprint or microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

Recent Books

(*Continued from page 100*)

Der Gleislose Erdbau

Part I of this book by Günter Kühn on earthmoving equipment describes the principal types and discusses their effective application. Part II deals with the planning, calculation, and organization of earthwork projects. Part III considers the economic aspects of such operations. Both caterpillar and wheeled types are covered, and considerable theoretical information is included along with the practical details. (Springer-Verlag, Berlin., 1956. 375 pp.. DM 39.00.)

Digital Differential Analyzers, An Applications Manual for Digital and Bush Type Differential Analyzers

Added to this edition are over a hundred pages of new material covering trajectory problems, simultaneous algebraic equations, partial differential equations, complex functions, conformal mapping, etc. The first part of the manual, a reprint of the second edition, shows the basic integrator mechanisms for the generation of exponential, trigonometric, algebraic, and inverse trigonometric functions. The author is George S. Forbes. (Third edition, 1956. Published by George F. Forbes, 10117 Bartree Ave., Pacoima, Calif. 154 pp., $7.50.)

Engineering Fluid Mechanics

The chief aim of this book by Charles Jaeger is to present the methods of analysis and calculation required in using water for power. The four major sections of the book deal with fundamental hydraulic principles, steady flow, unsteady flow, and flow in underground strata. Particular attention is paid to basic hydrodynamic equations, open-channel flow, surge tanks, and water hammer. Numerous bibliographical footnotes are included. The book is a revised and enlarged version of *Technische Hydraulik*, published in German in 1949 and in French in 1954. (Translated from German by P. O. Wolf. Published by Blackie and Son, Glasgow, Scotland. 529 pp., 60s.)

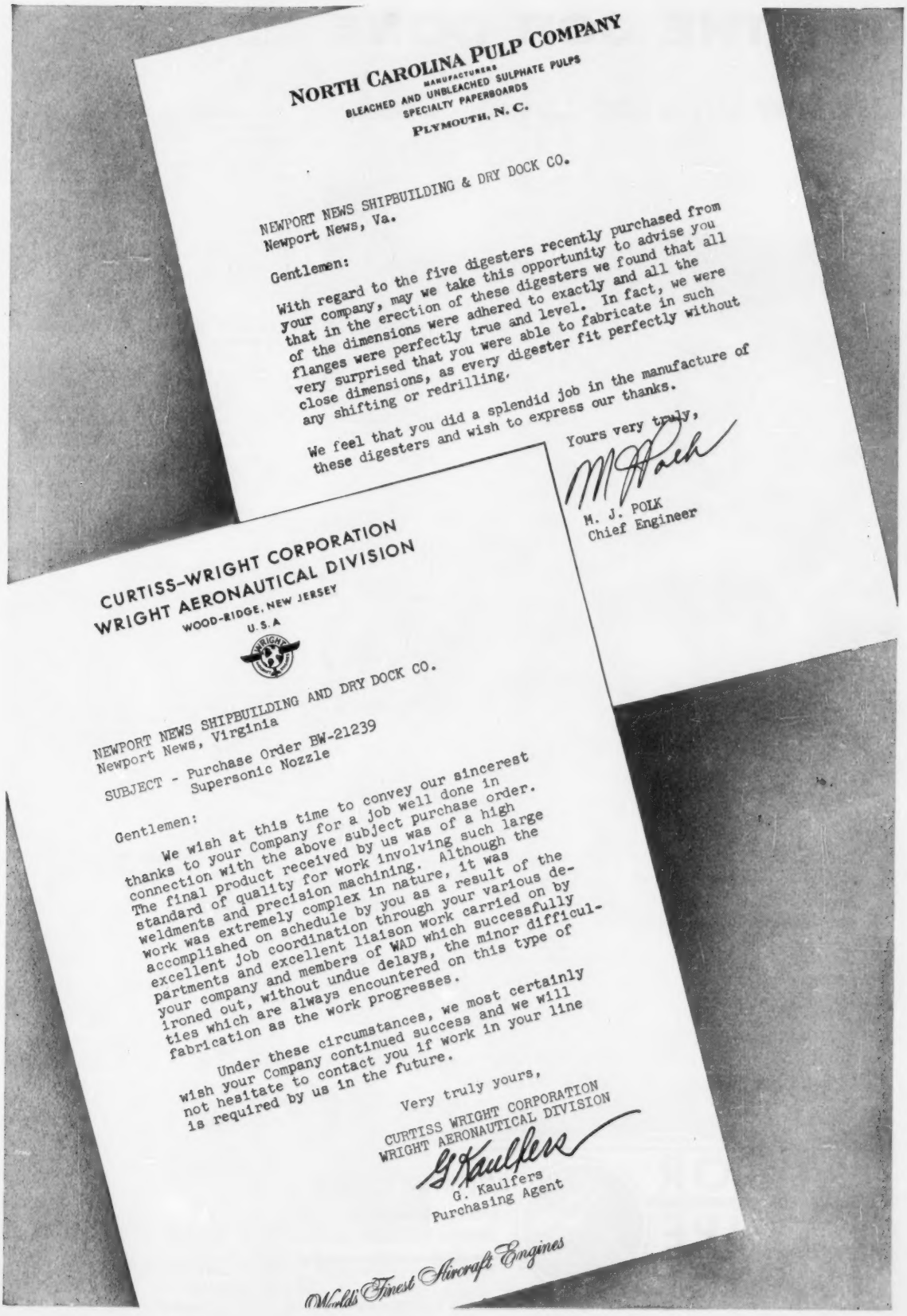
Foundations Design and Practice

Broad in scope, this reference manual by Elwyn E. Seelye provides the practicing engineer and student with the knowledge of theoretical design principles, practical construction techniques, and field conditions necessary for the design of a wide variety of structural types: bridge piers and abutments, foundations for pipes, embankments and pavements, retaining walls, etc. Such phases of the subject as subsurface exploration, inspection, specifications, estimates, contracts, and costs are fully treated, and tables of design data and criteria as well as numerous detailed drawings are used to supplement the text. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Various paging, bound, $16.00.)

Grund- Und Wasserbau in Praktischen Beispielen Volume I

This first volume of a practical treatise on foundation and hydraulic engineering by Otto Streck is in two parts: a discussion of foundation soils, covering their origins, types, methods of investigation, and foundation difficulties; detailed presentations of 17 practical problems in soil mechanics dealing with sheet piling, massive foundations, pile foundations, hydrostatic pressure, compressed-air caissons, ground water movement, etc. (Second edition, 1956, Springer-Verlag, Berlin. 416 pp., bound, DM 31.50.)

(*Continued on page 104*)



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We feel that you did a splendid job in the manufacture of these digesters and wish to express our thanks.

Yours very truly,

M. J. POLK
Chief Engineer

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We wish at this time to convey our sincerest thanks to your Company for a job well done in connection with the above subject purchase order. The final product received by us was of a high standard of quality for work involving such large weldments and precision machining. Although the work was extremely complex in nature, it was accomplished on schedule by you as a result of the excellent job coordination through your various departments and excellent liaison work carried on by your company and members of WAD which successfully ironed out, without undue delays, the minor difficulties which are always encountered on this type of fabrication as the work progresses.

Under these circumstances, we most certainly wish your Company continued success and we will not hesitate to contact you if work in your line is required by us in the future.

Very truly yours,

CURTISS WRIGHT CORPORATION
WRIGHT AERONAUTICAL DIVISION

G. Kaulfers
Purchasing Agent

World's Finest Aircraft Engines

Recent Books

(*Continued from page 102*)

Hütte

The main topics dealt with in the present volume of this standard German handbook for engineers are statics; wood, steel, and concrete construction; water supply and sewage; heating and ventilating; construction machinery; city planning; dams; tunnels; foundations; bridges; and highways. In this edition, some textual revisions have been made, some new material is supplied in a supplementary section, and a new section covering prestressed concrete and compound construction has been added. (28th edition, 1956. Wilhelm Ernst und Sohn, Berlin. 1,616 pp., DM 42.00.)

Hydraulics Refresher for Professional Engineers License

These selected examination questions by John D. Constance, with worked out solutions, deal with hydrostatics, hydrodynamics, circular orifices, weirs, flow through open channels, pipe flow, and centrifugal pumps. Concise reviews of each subject precede the illustrative problems. New topics included in this edition are specific gravity and density relations; valve testing conversions; branch piping networks; and nozzle horsepower. (Second edition, 1956. Published by John D. Constance, 526 Hudson Terr., Cliffside Park, N. J. Various pp., $3.00.)

Modern Brickmaking

This revision of a classic in the field by Alfred B. Searle is a detailed exposition of all the better-known processes, machines, and equipment in use in Great Britain and Europe, with some reference to American practice. Chiefly intended as a guide to the selection of plant and production methods, the book emphasizes practical considerations in dealing with clays and non-clay materials; digging and preparation of clays; selection of factory site and manufacturing processes; hand and machine molding; the stiff-plastic, semi-plastic, and dry processes; kilns; and the manufacture of special types of bricks. Numerous revisions have been made to take into account advances made in recent years. (Ernest Benn, Ltd., London. 1956. 734 pp., bound, $12.50.)

Ordinary Non-Linear Differential Equations in Engineering and Physical Sciences.

Confined chiefly to the presentation of various analytical methods for the solution of engineering problems, this text covers equations readily integrable; equations having periodic solutions; the equivalent linear equation; equations having periodic coefficients; the method of slowly varying amplitude and phases; and graphical and numerical solutions. Among the new topics treated in this edition are phase trajectories, stability criteria, and fluid flow in two dimensions. The author is N. W. McTachlen. (Second edition, 1956. Published by Oxford University Press, 114 Fifth Ave., New York 11. 271 pp., $5.60.)

Power Plants

The new edition of this text, previously published under the title *Steam Power Plants*, has been broadened in scope to provide a coordinated treatment of all types of power-generation equipment. The material on internal combustion plants has been expanded, a new chapter on hydro plants has been added, and recent developments such as supercritical vapor cycles and nuclear power are discussed. Alexander H. Zerbin and Edwin P. Nye are the authors. (Second edition, 1956. International Textbook Co., Scranton 9, Pa. 655 pp., $8.50.)

(*Continued on page 106*)

Recent Books

(*Continued from page 104*)

Significance of Tests and Properties of Concrete and Concrete Aggregates

The nearly forty papers included are divided into four main groups, starting with those of a general nature, and continuing with papers on tests and properties of concrete, tests and properties of aggregates, and tests and properties of such other materials as water, curing materials, air-entraining admixtures, and mineral admixtures. Subjects not dealt with in previous editions include testing of ready-mixed concrete, setting time of freshly mixed concrete, petrographic examination of hardened concrete, and others. Most of the papers contain fairly extensive lists of references. [American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. (Special Technical Publication No. 169) 1956. 387 pp., $5.25.]

Structural Geology

Part one of this three-part treatise by L. U. DeSitter deals with a number of topics in theoretical structural geology, including properties of rocks, strain of rocks, fracturing and distortion, experimental tectonics, and structural petrology. Part two deals with individual structures, beginning with faults and simple folds and proceeding to more complex structures. The final part defines the characteristics of the larger structural units and discusses theories concerning their origin. Twenty pages of references are given at the end of the text. (First edition, 1956, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36. 552 pp., $8.00.)

The Design and Construction of Engineering Foundations

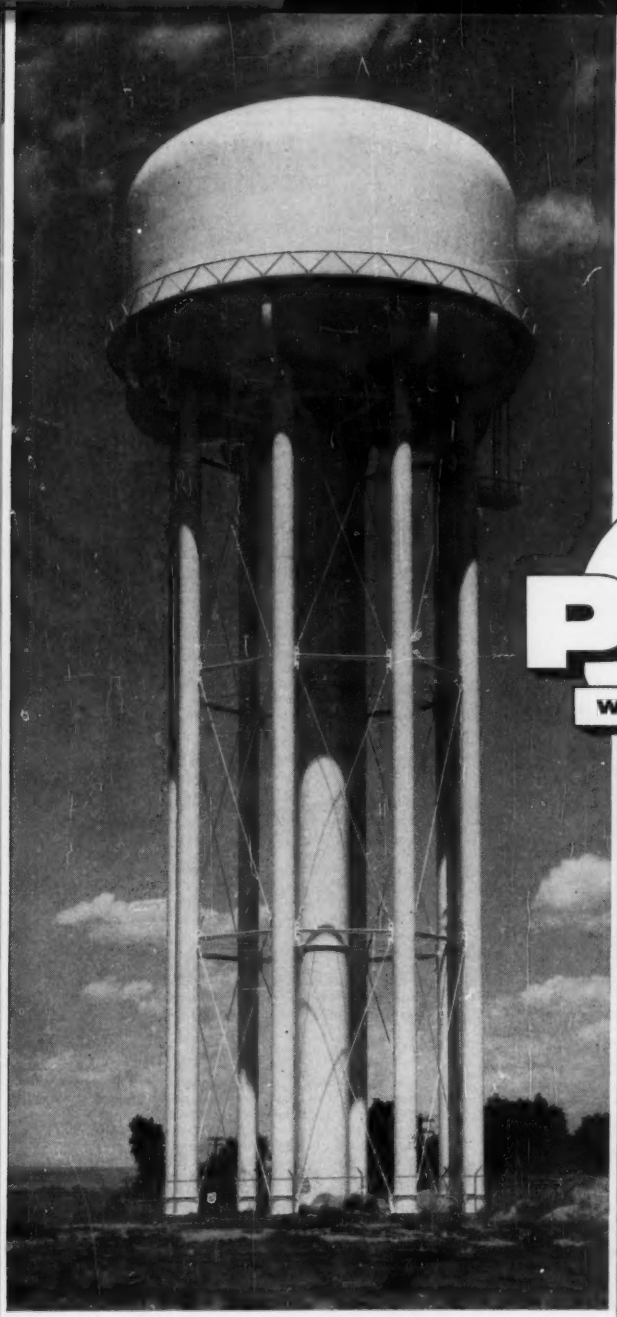
The aim of this reference book by F. D. C. Henry and text has been to link the design of foundations to the methods of structural analysis and soil mechanics (subjects discussed in early chapters), to present examples of good current practice, and to summarize relevant research. The structures dealt with include individual and continuous footings, rafts, retaining walls, culverts, cofferdams, caissons, piles, bridge abutments, piers, and structures subject to the effect of mining subsidence. (McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, 1956. 547 pp., $9.00.)

The Theory of Prestressed Concrete Design

A comprehensive theoretical treatment, based on British, American, and Australian practice. As well as dealing in detail with the design of the cross-section of pre-tensioned and post-tensioned beams, the book contains a chapter on the design of tanks and pipes. Other subjects covered include the design of the steel profile in eccentrically stressed beams, shear and torsion, bond and anchorage, deflection, and ultimate strength in bending. Henry J. Cowan is the author. (St. Martin's Press, 103 Park Ave., New York 17, 264 pp., $8.25).

The Ultimate-Load Theory Applied to the Design of Reinforced and Prestressed Concrete Frames

This is an exposition by A. L. L. Baker of a design method based on the assumption of plastic hinges in frames, developed at the Imperial College of Science and Technology in London. The following topics are treated: ultimate strength in bending of beams; plastic deformations of hinges and members; the theory of plastic hinges and the ultimate strength of frames; general expressions for rotations of plastic hinges; and general analysis of four-bay frames. Examples of applications of the plastic hinge theory in the design of continuous beams and building frames are given in the last chapter. (Concrete Publications, Ltd., London, England. 1956. 91 pp., $4.00.)



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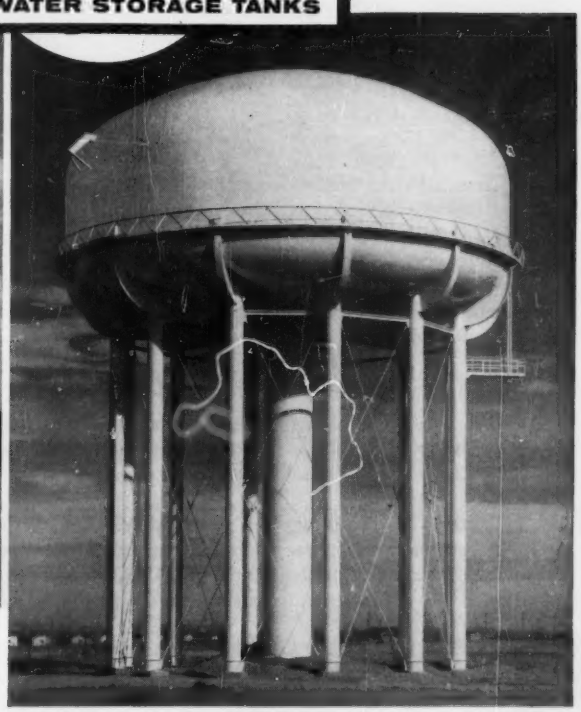

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WATER STORAGE TANKS

New Publications

Concrete research . . . Test results and conclusions of a laboratory investigation of the dimentional changes that take place in concrete masonry units when exposed to various simulated job-site and service moisture conditions are presented in Bulletin D3 of the Portland Cement Association. Also available from the same source is Bulletin D4, concerned with "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity." The authors are, respectively, Joseph J. Shideler and Carl A. Menzel. Inquiries should be sent to the Portland Cement Association, 33 West Grand Avenue, Chicago 10, Ill.

Engineering education . . . First in a projected series of studies dealing with the educational implications of current social developments is a publication of the Educational Policies Commission, entitled "Manpower and Education." The present critical shortage of engineers and scientists is the framework of the publication, which attempts to determine what the demands will be, and how they will be met. Copies of the 128-page publication are $1.25 in paper and $1.75 in cloth, with discounts available for quantity orders. Inquiries should be sent to the Educational Policies Commission, 1201 Sixteenth St., N. W., Washington 6, D. C.

Highway program . . . "The Highway Construction Industry in a Long-Range National Highway Program" is the title of a recent ARBA Task Force Report based on exhaustive studies by the engineering profession, leaders of industry, and expert officials in government. The information made available in the 61-page publication might well serve as a handbook to all segments of the highway industry to determine their expansion requirements to meet the increasing demand for men, materials, supplies, and equipment. Copies are $2.00 each, and orders should be sent to the American Road Builders Association, World Center Building, Washington 6, D. C.

Disaster studies . . . The Committee on Disaster Studies of the National Research Council—formed at the request of the Armed Services to conduct surveys and studies applicable to problems that might result from enemy action—has released the first four studies in a projected series. Currently available are Disaster Study No. 1, "Human Behavior in Extreme Situations: A Survey of Literature and Suggestions for Further Research"; No. 2, "A Study of Response to the Houston, Texas, Fireworks Explosion"; No. 3, "Tornado in Worcester, An Exploratory Study of Individual and Community Behavior in an Extreme Situation"; and No. 4 "Social Aspects of Wartime Evacuation of American Cities." Inquiries should be addressed to the National Research Council, 2101 Constitution Ave., Washington 25, D. C.

Nail popping . . . Studies of nail popping, its causes and prevention, are described by E. George Stern, M. ASCE, research professor of wood construction at Virginia Polytechnic Institute, in Bulletin No. 24 of the V.P.I. Wood Research Laboratory. The investigation was sponsored by the Independent Nail and Packing Company, of Bridgewater, Mass. Inquiries should be sent to Professor Stern at Virginia Polytechnic Institute, Blacksburg, Va.

Bridge design . . . Methods of designing highway and railroad bridges are presented in a 32-page lithoprinted bulletin by A. A. Eremin, A. M. ASCE, entitled "Highway and Railroad Bridges with Simple and Continuous Spans." For convenience of presentation the methods are illus-

(Continued on page 111)

(*Continued from page 70*)

Data, of General Electric, and sent me his reply containing the following ideas:

"There can be no disagreement that this is a problem that faces all engineers and scientists, and for that matter probably all professionals." "Something [of a solution] now exists in the form of the Engineering Index [located in The Engineering Societies Building]." "Perhaps the answers sought . . . could be obtained by expanding the Index."

"Mechanics Review, sponsored by ASME is another example . . . [of what can be done]. Similar action by the other societies might possibly be considered."

"...encourage more papers at [technical] meetings on the general topic of 'what's new in the engineering field as a whole.'"

"... [have] publishers of technical magazines . . . furnish with each issue, summaries of the articles it contains in the form of unified index catalogue cards. It is amazing to me that we, in the world's most progressive nation, keep on living with the situation in which it is left to thousands and thousands of libraries and the like to duplicate scan the same journals over and over in order to prepare entry cards which could be made out better and more speedily at the source, either by the authors themselves or by the publishing editor. There are a hundred and one imaginary objections to this idea, but I believe firmly that it deserves pushing to realization."

3. Michael A. Spronck, J.M. ASCE, Executive Field Editor of *Construction Equipment* writes: "A problem of collecting [technical] data is not an impossible one or even very great with modern card punching and electronic equipment. The rub comes in getting sufficiently well trained personnel to examine all of the source data and to analyze it, by subject, for an almost unlimited degree of future reference."

4. William P. Simpson, A.M. ASCE, writes, "I commend Esperanto . . . as an easy, practical solution to the problem[of dissemination of technical knowledge]. . . . A practical advantage, of course, is that a widespread demand (because the language could be read all over the world) would make for economical publication costs."

5. Aaron Fessler, Technical Librarian at The Cooper Union, observed to me that libraries are well equipped to organize such an endeavor. Further, he claims that we would benefit greatly if we knew how to more efficiently utilize the existing facilities of the libraries. Perhaps college course work in library usage should become mandatory for engineering students.

6. S. K. Ghaswala (see accompanying letter) points up particular applications to civil engineering of technical knowledge in the fields of aerodynamics, meteorology, and atomic energy. These examples illustrate the need for adequate intercommunication.

7. I might add the note that, as a concrete example of what can be done, the American Chemical Society maintains an extensive abstracting and indexing service called "Chemical Abstracts," with an entire building on the Ohio State University campus devoted to its publication. (See *Chemical and Engineering News*, March 5, 1956, p. 1104).

It would certainly be of value to the profession if some of the above excellent thinking could serve as the nucleus of some positive action to improve intercommunication.

Further, as I mentioned in the article, this improvement of intercommunication as well as the efficient utilization of developed information in the form of inventions should serve the profession and civilization well.

An uncontrolled flood of too much information is as poor as too little. For this reason, I see value in a central "invention" or "usage determination" team to perform the basic sorting and selection work for us.

This whole problem needs intelligent and orderly investigation. It is my hope that the original article as well as the above comments may trigger some effective action by technical societies on this important matter.

MILTON ALPERN, J. M. ASCE
Asst. Prof. of Civil Eng., The Cooper Union; and Consulting Engineer
New York, N.Y.

New Publications

(*Continued from page 108*)

trated by sketches, photos, and diagrams of bridges, and the distribution of bending moments in the continuous bridges and frames is shown by the graphical method. Copies may be purchased from Mr. Eremin, 1541-37th St., Sacramento, Calif., at $4.00 each, postpaid.

Hydraulic research . . . . Projects currently under way in hydraulic and hydrologic laboratories here and in Canada are listed in Miscellaneous Publication 218 of the National Bureau of Standards. Helen Middleton is author of the 216-page compilation, which sells for $1.50. Orders should be sent to the Government Printing Office, Washington 25, D. C.

Wood preservation . . . Availability of three new and fifteen revised standards for the AWPA Manual of Recommended Practice is announced by the American Wood Preservers Association. Of special note is the issuance for the first time of a standard covering the pressure treatment of railroad car lumber. The new standards will be sent to all owners as AWPA Manuals. A technical handbook of value to all producers and users of treated wood, the manual may be obtained at the AWPA headquarters, 839 Seventeenth St., N. W., Washington 6, D. C. The price is $7.50 plus postage.

Welding . . . The first specification on welding rods and electrodes used for "hard" surfacing has been issued jointly by the American Welding Society and the American Society for Testing Materials. Of special value is the Appendix, which can help users select the welding rod or electrode best suited to their needs. Identified as Specification AWS A5.13 and ASTM A399, the publication sells for 30 cents. Inquiries may be sent to either the AWS (33 West 39th St., New York 18, N. Y.) or the ASTM (1916 Race St., Philadelphia 3, Pa.)

Emergency and disaster planning . . . The importance of restoring water and sewerage utilities following enemy attack upon cities and towns or after natural disasters is highlighted in a new booklet, "Emergency and Disaster Planning for the Water and Sewerage Utilities," announced by the Business and Defense Services Administration of the U. S. Department of Commerce. The material in the booklet was prepared by a Task Group appointed by the Water and Sewerage Industry and Utilities Division of the Administration. Copies, priced at 20 cents apiece, may be obtained from the Office of Administrative Operations, U. S. Department of Commerce, Washington 25, D. C., or from Department of Commerce field offices.

Snake bite . . . Helpful to construction, pipeline, and similar workers in off-road terrain is a 50-page "Snake Bite Manual," recently released by the National Safety Council. The manual emphasizes that the search for new resources, the extension of communication and transportation, and the reclamation of new areas increase the hazard of snake bite to workers in such fields. It includes detailed instruction on how to identify poisonous snakes, where they are usually found, safe practices, protective clothing, and step-by-step treatment procedures. Copies are $1.50 each, and may be obtained from the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Technical and economic development . . . The proceedings of the one-day workshop sponsored by the National Conference on International Economic and Social Development, held in Washington in April, are reported in a 32-page bulletin entitled "The Forward Look in Technical and Economic Development." Free copies are available to schools and libraries; to others the price is $1.00 for five copies. Orders should be sent to the National Conference, 1025 Vermont Ave., N. W., Washington 5, D. C.

Non-ASCE Meetings

American Road Builders Association. ARBA Convention and Road Show at the International Amphitheatre in Chicago, Ill.. January 28–February 2, 1957. Information from Harvey A. Scribner, Chairman of the Road Show Publicity Committee, 155 North Wacker Drive, Chicago 6, Ill.

Associated Equipment Distributors. Thirty-eighth Annual Meeting of Associated Equipment Distributors at the Conrad Hilton Hotel, Chicago, Ill., January 27–30, 1957. Information from A.E.D., 30 East Cedar Street, Chicago 1, Ill.

Engineers Joint Council. Third Annual Assembly, Hotel Statler, New York, N. Y., January 17–18, 1957. Nuclear Congress, Convention Hall, Philadelphia, Pa., March 11–15, 1957. Information from EJC, 29 West 39th Street, New York 18, N. Y.

(*Continued on page 112*)

Non-ASCE Meetings

(*Continued from page 111*)

Society of Plastics Engineers, Inc. Thirteenth Annual National Technical Conference of the SPE, at the Sheraton-Jefferson Hotel, St. Louis, Mo., January 16–18, 1957. Information from James R. Davidson, Executive Secretary, SPE, 34 East Putnam Avenue, Greenwich, Conn.

Highway Research Board. Thirty-sixth Annual Meeting at Sheraton Park Hotel, Washington, D. C., January 7–11, 1957. Information from Fred Burggraf, Director, Highway Research Board, 2101 Constitution Ave., Washington 25, D. C.

Positions Announced

Boston Naval Shipyard. Qualified engineers to perform professional work in all branches of engineering are needed. The use of theoretical and applied mechanics, a knowledge of the properties of materials, and other appropriate engineering knowledges and skills are required. Positions are under Civil Service, with salaries ranging from $4,480 to $7,035 per annum. Application should be made to the Boston Naval Shipyard, Boston, Mass.

Corps of Engineers. The Alaska District, with headquarters at Elmendorf Air Force Base, Anchorage, announces immediate and critical need for 80 qualified engineers and inspectors. Civil Engineers, grades GS-9 and GS-11 with salaries ranging from $6,800 to $9,331.25. Inspectors, grades GS-7 and GS-9 with salaries from $5,625 to $7,812.50. For further information, applicants should write the District Engineer, Alaska District, Corps of Engineers, U. S. Army, Anchorage, Alaska, or information may be obtained from any District office of the Corps of Engineers in their area.

U. S. Department of Agriculture. The Soil Conservation Service has an opening for an Agricultural Engineer (Conservation) who will be under the general supervision of the Area Conservationist, with considerable latitude for independent action and decision. Location is Wausau, Wis., and salary $6,115 per annum. Applicants must meet requirements of Grade GS-7 engineers. Further information from Charles H. Buell, State Administrative Officer, Soil Conservation Service, 3010 E. Washington Avenue, Madison, Wis.

United States Navy. The District Public Works Office, Seventeenth Naval District, Kodiak, Alaska, has openings in various fields of engineering for design, construction and maintenance of naval shore installations in Alaska. Salaries range from $6,800 to $9,462, which includes a 25 percent territorial cost of living allowance. Tours of duty in Alaska are twelve months. Standard Form 57 obtainable from any post office or Federal Agency, should be completed and submitted to the District Public Works Officer, Seventeenth Naval District, Box 38, Navy 127, c/o Postmaster, Seattle, Wash.

University of Oklahoma, Norman, Okla. Teaching personnel for the Department of Mechanics, B.S. in engineering required, master's degree preferred. No teaching or industrial experience necessary. Salary range $4,000 to $6,500 for nine months. Rank and salary dependent upon qualifications.

Another city *using* AMERICAN'S *reinforced concrete pressure pipe for water supply lines*

The City of Phoenix, Arizona is another of the rapidly growing cities of the Southwest which have faced tremendous water supply problems and have met them successfully. The population of Greater Phoenix has increased almost 50 per cent in the past five years. An annexation program is currently increasing the rapid expansion of the City of Phoenix which is one of the fastest growing cities in the nation.

During 1953 American Pipe and Construction Company, through Fisher Contracting Company, general contractors, supplied Phoenix with more than 37,000 feet of large diameter concrete pressure pipe for a line which increased the Phoenix primary feeder capacity from 100,000,000 MGD to 210,000,000 MGD. The pipe furnished was pre-stressed concrete cylinder pipe designed for the operating pressures established under specifications prepared by Yost & Gardner, consulting engineers for the City of Phoenix.

American has helped to meet the special problems faced by Phoenix water officials by designing and supplying reinforced concrete pressure pipe especially for conditions in the Phoenix area.

A recent merger with Hooper Concrete Pipe Company in Phoenix gives American another permanent plant from which to serve the cities of the Southwest.

American Pipe and Construction Company makes available 49 years of experience and extensive production facilities to help solve any water supply problem. There is a type of American pipe to meet any requirement. Write or phone for complete information.

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Concrete pipe for main water supply lines, storm and sanitary sewers, subaqueous lines

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4635 Firestone Blvd., South Gate, Calif., Phone LOrain 4-2511

District sales offices and plants:
Hayward and San Diego, Calif., Portland, Ore., Phoenix, Ariz.

ENGINEERING SOCIETIES

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This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient nonprofit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

CIVIL ENGINEER, applying for Associate Member, ASCE; 1950 graduate, B.S. in C.E.; 32; single. Experience in construction and first order control. 6 years in Central and South America. Prefer overseas employment. Available November 1st. Presently in Columbia, South America. C-169.

SALES-CONSTRUCTION ENGINEER, A.M. ASCE; B.C.E; 31. 10 years' heavy construction experience, refineries, buildings, power stations. Speak four languages. Year and a half as Executive Assistant to Construction Manager, large engineering and construction firm. Single; relocate, available November 15th. Location desired; Overseas or West Coast. C-170.

CONSTRUCTION SUPERINTENDENT, A.M. ASCE; 30 years' varied and extensive experience in all phases of engineering design and construction; earthwork, steel and concrete structures, highways, underground installations, housing, refineries and petro-chemical plants. Executive ability. Capable of directing construction project of any magnitude. Prefer Southern location. Will accept foreign assignment. C-171-697-Chicago.

CIVIL ENGINEER, J.M. ASCE; M.C.E. 27; 2 years' experience in design and construction of industrial works in the chemical industry. Graduate training in the soil mechanics and foundations field. Will complete military in February, 1957. Location desired; West but will consider East or Midwest. C-172-San Francisco.

CIVIL ENGINEER, J.M. ASCE; B.S.C.E; 27; single; with experience in steel and timber structures: design, checking and drawing of plans; cost estimates; surveying and inspection of highway and railroad construction. Experience: 5 years' equally divided in field and office practice. Languages, Spanish and French. Available November 3rd, for position involving structural design, preferably connected with field supervision. Location desired; western U.S. or Foreign. C-173-696-Chicago.

SENIOR SOILS ENGINEER, J.M. ASCE; B.C.E; 31; 6 years' of soils and foundation experience. Field and design work; domestic and foreign. Location desired; United States. C-174.

CIVIL ENGINEER-ADMINISTRATOR, A.M. ASCE; B.S.C.E; 37; 15 years' field and office administration and engineering. Specialist in industrial and commercial building construction. Registered New York and Connecticut. Location desired; East or South. C-175.

STRUCTURAL DESIGNER, B.S.C.E. or Arch. E., 28 up, with 3 years in engineering office with similar duties; knowledge of design and drafting. Will do structural design of steel, concrete and timber for industrial buildings. Checking of structural shop drawings. Some structural drafting. Approximately 60 percent structural design, 40 percent drafting, for manufacturer of paints. Salary, $8,400 a year. Employer will pay the fee. Location, Chicago, Ill. C-5626.

Positions Available

ASSISTANT TO CHIEF ENGINEER, civil graduate, with New York State P.E. license and at least 6 years' experience in engineering surveys, tests, specifications, and reports covering highways, buildings, materials, equipment and controls. Salary, $7,100 a year. Location, New York, N. Y. W4006.

CIVIL OR STRUCTURAL DESIGNER, to assume responsibility for structural steel and reinforced concrete design. Must be willing to work on the board in connection with projects assigned to him. Salary, $5,000–$6,500 a year. Location, northern New Jersey. W4017(a).

GENERAL MANAGER, civil graduate, with at least 10 years' construction management experience covering responsibility for general supervision of sales, estimates, sub-contracts, and field supervision of public works, pipelines, excavations and general concrete construction. Must be Mexican citizen. Salary, $15,000–$20,000 a year, plus bonus. Location, Mexico. W4076.

POLLUTION ABATEMENT ENGINEER, degree in chemical engineering, or civil engineering with a minimum of 5 years' experience in field of chemical pollution abatement. Would involve experience in design of industrial plant facilities to process wastes from chemical operations as well as knowledge of sanitary disposal facilities. Should be familiar with State and Federal regulations on air and stream pollution. Will perform the engineering or supervise the engineering to design and specify installations for waste disposal as needed for new or existing operations, etc. Salary open. Some travel. Headquarters, Missouri. W4079.

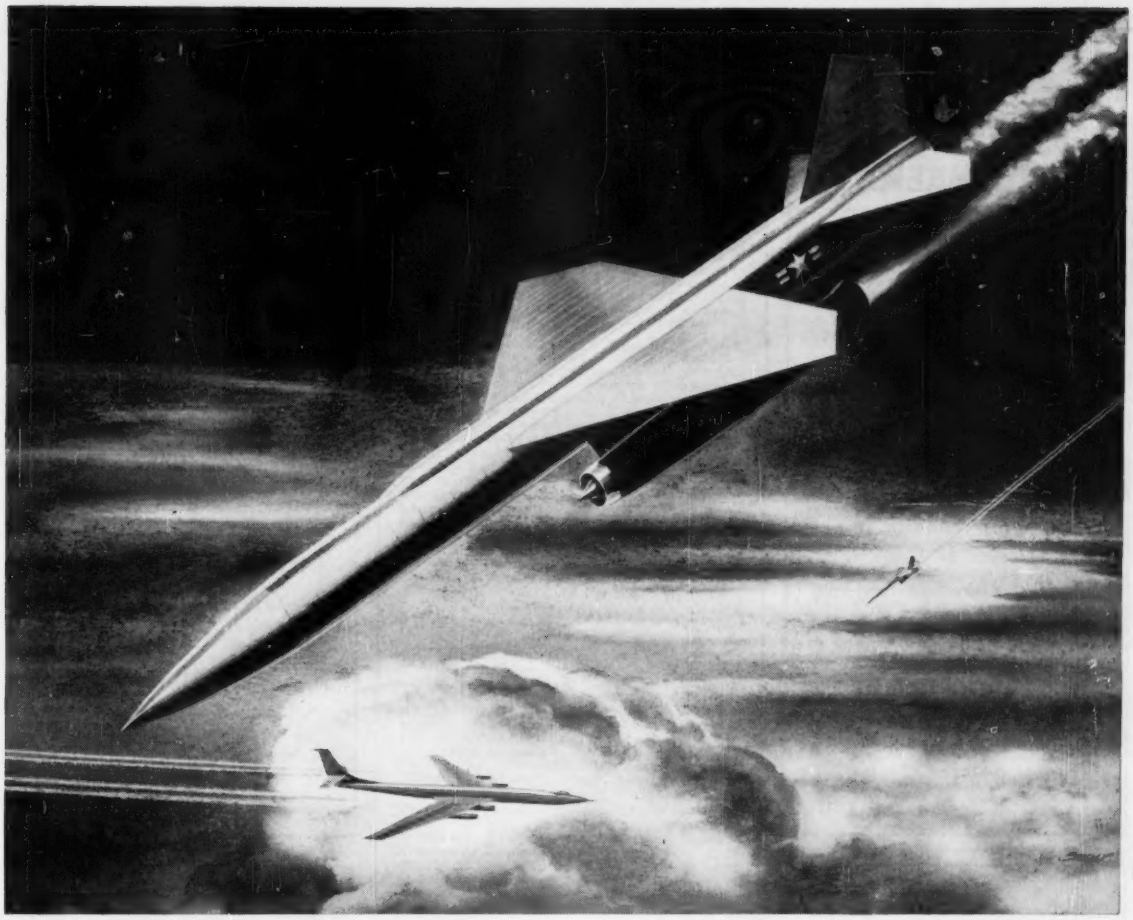
FIELD ENGINEER, civil graduate, with at least 3 years' heavy construction experience, including pile driving for marine pier terminal project. Salary, $10,000 a year. Duration, one year. Location, South America. F4104.

CONSTRUCTION SUPERINTENDENT, under 55, civil or mechanical graduate, with at least 10 years' supervisory construction experience covering power plants, mill buildings, roads and utilities. Salary, $10,000 a year, plus extras. Location, Cuba. F4117.

LABOR RELATIONS MANAGER, staff position, for large construction company. Must have experience in labor contracts, jurisdictional disputes, etc. Considerable travel. Salary, $10,000–$12,000 a year. Company will pay fee. Headquarters, Ohio. W4121.

PROJECT ENGINEER, 35–50, graduate civil or mechanical, with a minimum of 15 years' experience in heavy chemical plants with metallurgical ore dressing and open pit mining. Experience in engineering design essential. Will be responsible for overall design and coordination of work con-

(*Continued on page 116*)



Boeing "C.E.'s" help develop new defense weapons system

Boeing's BOMARC IM-99 is a long-range guided missile designed to strike enemy bombers while still over areas away from vital targets. It's a supersonic spearhead of an entire defense weapons system that includes communications, bases, logistics.

Civil engineers at Boeing have made major research contributions toward the development of this vital weapons system. Their guided missile work, most of it at the very frontiers of knowledge, includes airframe design for maximum strength to weight ratio and a maximum high temperature, strength and flexibility analysis for dynamic loads, and structural analysis utilizing minimum factors of safety. If pioneering appeals to you, and if you enjoy working with engineers of outstanding professional stature, you'll like Boeing.

And you'll find plenty of room for advancement. Boeing's growth — a 400% jump in the number of Boeing engineers in the last 10 years — assures openings ahead, and job stability. Boeing promotes from within, and every six months a merit review gives each engineer a *personal* opportunity for recognition, advancement, increased income.

Starting salaries at Boeing are high, and the company pays moving and travel expenses. If you are interested in continuing graduate studies, Boeing will arrange a special work schedule for you and pay all tuition and fees. Other Boeing advantages include a liberal retirement program and the backing of outstanding research and test facilities. Your family will enjoy life in any of the three young-spirited communities in which Boeing is located. Pick the climate and living advantages that suit you best. Each offers an abundance of recreational activities, plus good housing, schools, convenient shopping centers.

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Men and Jobs Available

(Continued from page 114)

sisting of the following: dock construction, dredging operations, belt conveyors, storage, kilns, dust collectors, power house, maintenance facilities, mining equipment, etc. Salary open. Location, California. W4126.

TEACHING PERSONNEL, Master's degree in civil engineering preferred but will consider Bachelor's degree in civil, with or without experience. (*a*) One needed to teach statics, dynamics, strength of materials, hydraulics and surveying. (*b*) One to assist in courses in structures and reinforced concrete theory. Salary, $4,200–$5,400 for nine months. Positions available in February 1957. Location, Southwest. W4128S.

ENGINEERS. (*a*) Research and Development Engineer, B.S.C.E. or Master's degree, with field experience in irrigation for work on canal lining. (*b*) Research and Development Engineer, B.S.C.E. or Master's degree, with experience on soils for work on canal lining. Salaries dependent upon experience and qualifications. Location, Colorado. W4162.

TEACHING PERSONNEL. (*a*) Associate or Assistant Professor, M.S. or Ph.D., with industrial experience desirable, to lead academic program instructures. Opportunity for research. (*b*) Research Engineer, M.S. or Ph.D. for irrigation work, principally ground water. Field experience desirable. Limited teaching. Salaries dependent on qualifications. Location, Colorado. W4163.

HEAD OF STRUCTURAL DEPARTMENT, with experience in both the office and in the field of structural steel, reinforced concrete and foundation design for buildings and hydraulic structures. Must have leadership ability and experience directing structural design personnel. Will be responsible for the structural design of all projects as well as the administration and supervision of structural engineering and drafting personnel. Salary open. Location, Massachusetts. W4181.

HEAD OF DEPARTMENT, for civil engineering; Ph.D. preferably, for recognized university. Must have considerable past teaching experience. Position available June, 1957. Location, New York State. W4183.

SENIOR INSPECTOR, with at least 10 years' experience on steel bridge construction. Salary, $10,000–$12,000 a year, plus extras. Location, Columbia. F4186.

SENIOR BUILDING CONSTRUCTION ENGINEER, New York State P.E. license required, with at least 2 years' of satisfactory professional engineering or architectural field experience in the supervision of building construction projects. Will review plans, specifications, and estimates for building construction; authorizing and recommending changes to meet local conditions. Salary, $6,900 a year. Location, upper New York State. W4191.

DESIGN ENGINEER for leading manufacturer of core drills and drilling accessories. Will be responsible for the design and development of drilling equipment as well as direction and supervision of necessary drafting personnel. Creative as well as executive ability desirable. Salary open. Location, Pennsylvania. W4199.

ASSISTANT CHIEF ESTIMATOR experienced in estimating cost of construction of industrial buildings, in preparation for pricing by others, budget estimates for all trades, except mechanical or electrical, from preliminary plans. Salary, $9,100 a year. Location, New York, N. Y. W4227.

ADMINISTRATIVE SECRETARY for national engineering society. Must have ability in management, public relations, publication production, advertising, publicity programming, membership activities and budgets. Salary open. Location, Midwest. W4236.

ASSISTANT OR ASSOCIATE PROFESSORS, Ph.D. preferred, M.S. acceptable, for civil engineering department. Part time research and part time graduate and/or undergraduate teaching. Must have special training or experience in highway engineering or in structures. Salaries, on a 12-month basis, $6,000–$7,500 a year. Location, South. W4237.

CIVIL ENGINEERS. (*a*) Civil Engineer, graduate, with about 3 years' varied experience in municipal work, particularly on streets and sewers, to make surveys, designs, plans and estimates and supervise construction of sanitary sewer extensions, storm sewers, street improvements, etc. (*b*) Junior Civil Engineer, graduate, with about one years' experience in civil engineering with some knowledge of streets and sewers. Will assist in making surveys, designs and plans and estimates, etc., as above. (*c*) Assistant Building Inspector, graduate civil, with about a year of experience in inspection or construction municipality. Location, New Jersey. W4244.

RESIDENT ENGINEER, graduate civil, experienced owner's representative for construction of process industrial plant. Knowledge of Spanish; good record. Large, expanding company with opportunity for excellent permanent connection. Location, Venezuela. F4266.

Applications for Admission to ASCE, Oct. 13–Nov. 3, 1956

Applying for Member

GIBSON MILTON ALLEN, New York, N. Y.
CHARLES HUTCHINGS BONNEY, Nashville, Tenn.
HARLAN PAGE BOSWORTH, JR., Medford, Oreg.
REX V. CAMPBELL, Detroit, Mich.
LAURENCE WHEELER DABNEY, Atlanta, Ga.
DONALD BYRL DAVIDSON, Buena Park, Calif.
FRANCISCO DEL CAMPO OLIVA, Sao Paulo, Brazil.
M. P. FRANK, Denton, Tex.
FORREST DORSEY GARRETSON, Pittsburgh, Pa.
RAYMOND EDWIN GREEN, Cleveland, Ohio
GILBERT GROFF, Salem, Oreg.
SANKEY ARTHUR GUNN, Orange, Tex.
FOREST ROY HALL, Carson City, Nev.
HAYDN RECORDS HUNTER, Wichita, Kans.
BENOIT GEORGES JOUBERT, Bozdogan, Turkey.
ELMER CLIFFORD LEE, San Carlos, Calif.
CLAYTON HUNG-EN LEM, Hong Kong, China.
RAYMOND JOHN LENZ, Cincinnati, Ohio.
PETER STANLEY MARRA, Mineola, N. Y.
ROBERT DILLON MCCLINTOCK, Detroit, Mich.
FREDERICK CLEMONS MILLER, Toledo, Ohio.
HENRY CARLES PFANNKUCHE, Dallas, Tex.
DONALD DANA RIDDLE, Savannah, Ga.
ANDREW MYRON SCHERFFIUS, JR., Aiken, S. C.
THOMAS WILSON SEIBERT, Augusta, Ga.
MARTIN STANDARD, New Orleans, La.
ROMAN WLADIMIR SZECHOWYCZ, Ceylon, India.
HUBERT JEROME TRACY, Atlanta, Ga.
JULIAN JORDAN TURNER, Phoenix, Ariz.
ARTHUR GRANT VILLEPIQUE, Glen Rock, N. J.
DAVID ROGERSON WILLIAMS, JR., New York, N. Y.
GAETAN MARC ZUCCO, Los Angeles, Calif.

Applying for Associate Member

ROBERT LESLIE ARMSTRONG, Los Angeles, Calif.
ROBERT MILTON ARTHUR, Terre Haute, Ind.
JOHN P. BARA, Denver, Colo.
PAUL ALBERT BECKMANN, JR., San Antonio, Tex.
VITELMO VICTORIO BERTERO, Cambridge, Mass.
JOHN DOUGLAS BLACKBURN, Los Angeles, Calif.
JOSEPH JOHN BONGIOVANNI, East Syracuse, N. Y.
JAMES FREDERICK BREAKER, El Paso, Tex.
CHARLES RUSSELL BUCK, Kansas City, Mo.
OSSIAN RUFUS BUTTERFIELD, Yorktown, Va.
LEO JOSEPH CANTOR, Richmond, Va.
PAUL JOHN CLAFFEY, Washington, D. C.
PLATO COLLINS, Albany, Ga.
CHARLES WEIDNER DEAKYNE, Baltimore, Md.
DANIEL RUDOLPH DICKINSON, Overland Park, Kans.
EDWARD GUMMERT ECHEVERRIA, Bogota, Colombia.
ARTHUR WILLIAM HIGHLEY, Los Angeles, Calif.
KENNETH MARK HUBER, Princeton, N. J.
JAMES NEAL HUTCHINSON, Jacksonville, Fla.
JACK RAYMOND JANNEY, Skokie, Ill.
JOHN DAVID JONES, Akron, Ohio.
NAZIR AHMED KHAN, Chandraghona Ctg. Hills, East Pakistan.
VERNON DALE LANE, Dallas, Tex.
GROVER MARVIN LITZ, Los Angeles, Calif.
ULYSSES MONTGOMERY, Los Angeles, Calif.
THEODORE HARRISON MOSER, El Paso, Tex.
JEAN MULLER, Paris, France.
KENNETH ELMORE NORTHRUP, Rockville, Md.
JAMES BERNARD O'CONNOR, Jamaica, N. Y.
ALDO SALVATORE PALMERI, Rutherford, N. J.
KENNETH ARTHUR PATCHEN, Towson, Md.
JOHN DALE PIANTA, JR., San Antonio, Tex.
MARIAN PONA, Whittier, Calif.
SYDEN PREEN, Long Beach, Calif.
VINCENT RAMIREZ, Los Angeles, Calif.
LEROY GILES RATHBURN, Honolulu, T. H.
HEM LAL SAHA, Rangoon, Burma.
JOSEPH MARION SANCHIS, Los Angeles, Calif.
DONALD RICHARD SATTERTHWAIT, Santa Paula, Calif.
PAUL JOSEPH SCHMITZ, Easton, Pa.
WILLIS WARD SMITH, Milwaukee, Wis.
HAROLD WARNER STIVERS, Richland, Wash.
JOHN FRANCIS STOLZ, Woodland Hills, Calif.
MAURICE CLAYTON STOUT, Indianapolis, Ind.
BRUNO THURLIMANN, Bethlehem, Pa.
ARDIS CORNELIUS VAN TASSEL, Dallas, Tex.
STANLEY AUGUSTUS WILFONG, Los Angeles, Calif.

Applying for Junior Member

ANGEL AUSTRIA ALEJANDRINO, Minneapolis, Minn.
LUIS JORGE ARISTIZABAL, Medellin, Colombia.
JOHN CHARLES BEE, JR., Augusta, Ga.
LAWRENCE HENRY BUSH, Champaign, Ill.
BEVAN WOOD BROWN, JR., Knoxville, Tenn.
ROBERT JAMES COLLERAN, New York, N. Y.
FREDERICK BERNARD DEWY, Portland, Oreg.
DEMETER GEORGE FERTIS, Lansing, Mich.
ALAN STEWART GOODYEAR, Victoria, B. C.
BILLY JAMES GUIN, Shreveport, La.
HAROLD CLIFFORD HALL, Kansas City, Kans.
PETER EDWARD JOSELIN, New Orleans, La.
EMIL GENE LARSON, San Francisco, Calif.
GUY JEAN-MARIE LEMOIGNE, Ithaca, N. Y.
JIMMY BANKS LONG, Nashville, Tenn.
PRAGNJONO MARDJIKOEN, Berkeley, Calif.
GEORGE TERRELL MAYES, Urbana, Ill.
DONALD WALTER OTTENS, Trenton, N. J.
HAZIM JAMIL RASSAM, Baghdad, Iraq.
JOHN EDMUND SCHUMACHER, Wauwatosa, Wis.
CHARLES YU TEKLET, New York, N. Y.
JOSEPH WARWARUK, Urban, Ill.
JOHN ROBERT WOTELL, Baltimore, Md.

[*Applications for Junior Memberships from ASCE Student Chapters are not listed*]

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Interchangeability—Marks New Line of Scrapers, Shovels and Dozers

THE FAST GROWING Clark Equipment Company, with a sharp eye on the $34 billion highway program, has broadened its line of construction equipment with the addition of a line of tractor scrapers, and tractor dozers. Major additions were also made to the present line of

Michigan 375A

Michigan tractor shovels. Scheduled for unveiling at the forthcoming Road Show, production is being planned to meet the demands of the 1957 construction season.

Big feature of the new lines is the stress put on interchangeability of power train components. This was emphasized by C. E. Killebrew, V. P., of Clark, when he said, "Equipment of corresponding capacities will utilize the same power shift transmissions, torque converters and axles as well as the same engines. This will result in matched horsepower and matched speeds throughout the capacity range for our lines of tractor shovels, tractor dozers and tractor scrapers." This should materially reduce parts inventory—a significant feature in the highly competitive heavy construction industry.

In the tractor scraper three models are being produced: Model 110, 8 to 10½ cu yd capacity, 165 hp, Model 210, 12.7 to 18 cu yd 210 hp, and Model #310, 20 to 27 cu yd 335 hp. Rated top speed is 30 mph. The 110 can turn on a 30-ft diameter. Scraper controls are completely hydraulic.

The two new items in the shovel line are the 375A, 6 cu yd capacity and the 275A with a 4 cu yd capacity. The 6 yd unit is powered with a Cummins turbocharged diesel engine. Both machines have four speeds forward and four speeds reverse with a top road speed of 28 mph.

In capacities matched to the line of scrapers, two new dozers, the Model 280 and the Model 380, have been added to last years' Model 180. The 280 is a 38,000-lb vehicle with an 11-ft 3-in. blade and the 380 is a 55,000-lb vehicle

Model 110 and 180

with a 13-ft 3-in. blade. The horsepower is matched to the 210 and 310 scrapers. Top speed forward and reverse is 28 mph. The ends of the blades are fitted with replaceable cutting edges. **Clark Equipment Co., CE 12-118, Benton Harbor, Mich.**

New Concrete Cutting Diamond Blades

FOUR NEW CONCRETE CUTTING Diamond Blades, two for cutting old concrete and two for sawing green concrete, have been developed and are now being marketed. The CD-68-3, made in the 1/8-in. width with a 3/16-in. depth is ideally suited for sawing old concrete containing aggregates of medium hardness. The CD-78-3, also made in the 1/8-in. width with a 3/16-depth, may be used for sawing old concrete containing favorable aggregates and should be used on saws with 25-hp or more. This blade also gives low cost cutting when used on asphalt, and when used on this material, it is not necessary to saw with a higher horsepower unit.

The CD-69-3 and CD-79-3 are made in the 9/64-in. width and have a 3/16-in. diamond depth. Both were developed for sawing green concrete. The CD-69-3 will saw control joints in all types of aggregates but is best suited for aggregates of the medium-to-hard groups, such as granite and river gravel. It has been successfully used in cutting joints in concrete as old as seven days with 25-hp saws or larger.

The CD-79-3 is best suited for sawing green concrete with a medium type aggregate such as weathered granite, dolomitic limestone, and slabs containing river gravel with a mixture of limestone. **Clipper Mfg. Co., CE 12-118, 2800 Warwick, Kansas City, Mo.**

Stacker

MODEL OF GIGANTIC 275 foot radius traveling belt conveyor stacker, believed to be the world's largest, was displayed at the 1956 Convention of the Iron and Steel Expositions in Cleveland, Ohio, September 25–28 and at the American Mining Congress 1956 Mining Show in Los Angeles, California, October 1–4.

This hugh self-propelled stacker is now in the process of erection for Erie Mining Company at Hoyt Lakes, Minn. It will be used to stockpile taconite pellets pro-

duced during the five winter months when navigation on the Great Lakes is closed and is capable of stockpiling a 90-ft high mountain of more than 4,000,000 net tons of taconite pellets covering an area approximately 800-ft wide at the base and 1,300-ft long. The stacker will be fed by a trailing belt conveyor about 1,400-ft long which moves with the stacker. When navigation resumes in the spring the taconite pellets will be reclaimed for shipment to lower lake steel mills. **Link-Belt Co., CE 12-118, Prudential Plaza, Chicago 1, Ill.**

Plastic Sheets

DEVELOPMENT OF A NEW, flexible foamed plastic sheet insulation that adapts itself to curved or irregular surfaces with little or no fitting or cutting has been announced.

Called Armaflex Sheet Insulation, the new product is formed from the same basic material as Armaflex Pipe Covering, which has gained wide use in the air-conditioning field since its introduction two years ago.

The flexibility of the new sheet form makes it particularly adaptable to insulating large tanks, irregularly shaped vessels, oversize pipes and refrigeration and air-conditioning equipment.

The material will withstand temperatures as high as 160-deg F, with no limitation at the low end of the temperature scale, since thickness can be built up by applying successive layers.

Armaflex sheets have a k factor of 0.28 at 75-deg F mean temperature and a water vapor permeability of 0.1 perm. They are available in thicknesses of 1/8, 1/4, 1/2 and 3/4-in. in sheets 30 × 36-in.

The foamed plastic sheets are applied to almost any clean, dry surface with an adhesive supplied by Armstrong and do not require any mechanical supports, or any other sundry materials. No vapor barrier is necessary, but it is recommended that outside installations be protected by an application of aluminum or asphalt paint. **Armstrong Cork Company, CE 12-118, Lancaster, Pennsylvania.**

EQUIPMENT MATERIALS and METHODS

(continued)

Hydraulic Jacks

TANGYES "HYDRALITE" JACKS ARE made in 15, 25, 35 and 50-ton sizes. Each have a 6″ power lift, except the 35-ton which has a lift of 18″. Alternatively for the 15 and 25-ton Jacks, a 12″ power lift is available.

All working parts are totally enclosed and automatically lubricated by the hydraulic fluid and the cylinder is protected from ingress of dirt and grit, etc., by a ram wiper seal, ensuring trouble-free operation under extreme conditions. Synthetic rubber seals are employed throughout. They are completely automatic in their action and have excellent friction and wearing properties. In addition they offer very high resistance to hydraulic fluid and climatic conditions. A strong rigid base in the form of a one-

15 Ton

piece aluminum alloy billet provides adequate protection from loads induced by uneven jacking surfaces. Contained in the base are all the valves and fluid lines, adequately protected from dirt by a built-in, large capacity suction filter. The ram and cylinder are aluminum alloy extrusions, accurately finished to give a close sliding fit. The cylinder is bonded into the base and positively sealed. The ram is marked to indicate the safe limit of lift, and is protected by a toughened steel cap. Construction of the Hydralite is such that the full power and load can be achieved when the jack is operated in a horizontal position, when the jack is lying on its front face, which is designed for this purpose.

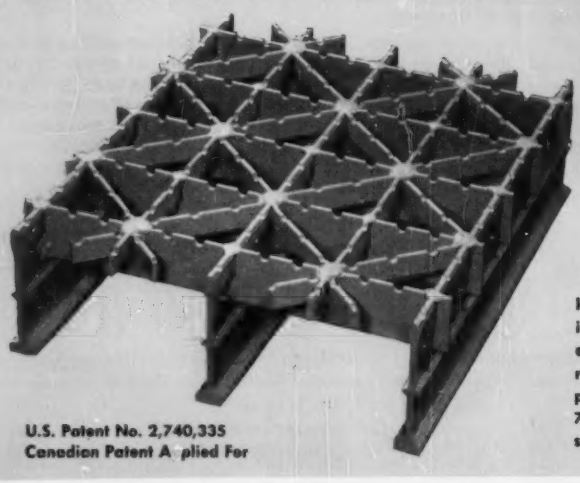
The first Hydraulic "Ship" Jacks were made by Tangyes in 1870 and have been continually improved. **Tangyes of Canada Limited, CE 12-119, 1215 Greene Ave., Montreal 6, Canada.**

New GREULICH 4-way GRID

Holds Installation and

Skid-resistant, flat, serrated surface .....

Bascule bridge, New Iberia, La. Contractor: F. Miller & Sons, Lake Charles, La.



U.S. Patent No. 2,740,335
Canadian Patent Applied For

Greulich 4-Way Grids

Precision manufactured. Comes out square and rigid, assuring true alignment. Will not rack.

Integrally connected triangles extend over entire roadway insuring maximum lateral or horizontal rigidity and high skid resistance. They are especially adaptable for reflooring old bridges. Solid, 5-inch deep units remain true during shipment, handling and erection. Test data available proving resistance to distortion. Grids made in lengths up to 36 feet and 7 feet 3 inches widths to reduce number of units to be handled and field splices to be made between grids.

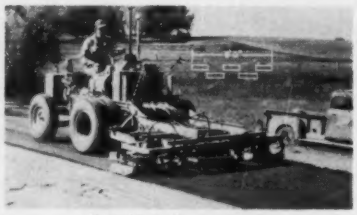
EQUIPMENT MATERIALS and METHODS

(continued)

Multiple Compactor

THE EXTRAORDINARY FLEXIBILITY of the Multiple Compactor is derived from the fact that each of the six compacting units may be independently operated. They can be arranged and rearranged to provide a very efficient coverage and consolidation of granular soils, rock, slag, sand or gravel, as used in sub bases, bases of macadam pavement, pavement widening, projects and fills of various kinds.

The working width of the machine, normally 13-ft, 3-in., when all units are used in line, may be reduced by any number of units to suit the width of



A 5-Unit Arrangement

project. Units may likewise be arranged in tandem, three following three, for maximum one-pass consolidation; three and two staggered to exactly fit width, or towed in tandem at the side of tractor for certain pavement widening projects. Furthermore, individual compactor units may be taken from the Multiple's workhead, fitted with operating handles and used exactly as are the selfpropelled, manually guided compactors so popular for compacting areas which are inaccessible to the larger machines. **Jackson Vibrators, Inc., CE 12-122, Ludington, Mich.**

Package Assembly

A MID-WESTERN FIRM, makers of earth anchors for guying electric and telephone lines, oil rigs and derricks, and anchoring pipelines is now introducing a single package assembly for anchoring underground fuel tanks to prevent "floating" when they are empty or only partially filled. This complete package provides a new method of attachment that permits an easy and secure installation with ordinary tools, and consists of 2 anchors, either screw type or expandable, whichever is preferred, complete with rods for "banding" over the tank and for anchor attachment. The "banding" rods are joined over the top of the tank with a connecting lug which permits 12 in. of take up on the threaded end of each rod.

The standard package is made for $5^1/_2$ to 6-ft diam tanks; however, the assembly is available to fit any diameter. **The A. B. Chance Co., CE 12-122, Centralia, Mo.**

TURNPIKE TESTS PROVE:

"75" PAYSCRAPER®

CARRIES

12% more...

DELIVERS IT

15% faster

• • • • •

TD-24 push

An International TD-24 tractor and "75" Payscraper recently out-pushed, out-loaded, and out-sped all equal-sized competitive units in accurate on-the-turnpike tests. This data was obtained on the Illinois toll road job near Rockford.

All tests were conducted under similar conditions on the same cut, in the same material, and under the supervision of the contractor's grade foreman. Loading time was limited to exactly one minute. Scraper loads were weighed on special new accurate scales. Haul length was held to 2,000 feet for all scrapers.

Final figures amazed all observers! Results showed first, that *the "75" Payscraper carried 12% more dirt per load...delivered it 15% faster than the other two scrapers tested;* second, that *the TD-24 torque converter pusher heaped an average of 1.2 cu yd extra into all scrapers tested.* (See charts, at right.) A competing manufacturer substantiated these same figures!

Here's conclusive proof that no matter what scraper the TD-24 pushes, you load more in any given time... and that the "75" Payscraper carries more, no matter what pushes it! And that the TD-24 and "75" Payscraper, teamed together, out-produce other equipment combinations with faster loading, bigger loads, and all-around faster cycles.

Prove the stand-out pushing, loading, and cycle-speeding performance of the International TD-24 tractor and "75" Payscraper on your own jobs. Ask your International Construction Equipment Distributor for a demonstration!

Load-Speeding Action. High horsepower-to-weight ratio and speeds up to 24 mph—plus operating ease of air-assisted clutch; big, safe, 4-wheel air brakes; exclusive Hydro-Steer—all help the Payscraper gain time, increase earth-moving capacity!

Clipboard in Hand, equipment engineer signals "75" to begin controlled one-minute push-loading from TD-24 torque converter tractor. Although TD-24 push-packed an average 1.2 cu yd more in all scrapers, it loaded 2.1 cu yd more in "75" Payscraper, than competing pusher!

loads 1.2 extra yds. into all scrapers!

PAYLOAD TESTS (average)

Pusher	International "75" Payscraper	Scraper "A"	Scraper "B"
International TD-24 Torque Converter tractor	20.6 cu. yd.	18.2 cu. yd. "75" bonus 2.4 cu. yd.	17.5 cu. yd. "75" bonus 3.1 cu. yd.
Pusher "A"	18.5 cu. yd.	17.0 cu. yd. "75" bonus 1.5 cu. yd.	17.1 cu. yd. "75" bonus 1.4 cu. yd.

CYCLE TIME TESTS (average)

International "75" Payscraper	4.8 min.
Scraper "A"	5.7 min.
Scraper "B"	5.6 min.

"75" Payscraper Proves 15% faster ... delivers up to 19 extra loads per 10-hour day

See you at the ROAD SHOW—CHICAGO Jan. 28-Feb. 2, 1957

INTERNATIONAL HARVESTER

INTERNATIONAL® Construction Equipment

International Harvester Company, 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel and Pipe-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Motor Trucks

EQUIPMENT MATERIALS and METHODS

(continued)

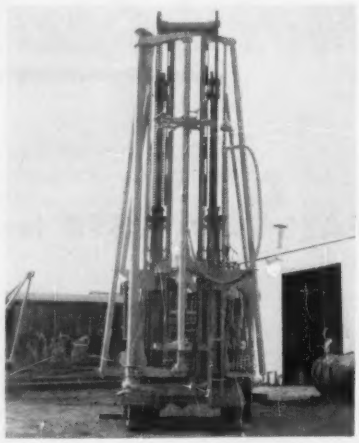
Rotary Drill

A NEW, DRY TYPE, LOW-COST rotary drill, the invention of a mine that saw its profit being eaten away by high drilling and blasting costs, is proving its superiority over wagon drills, churn drills, auger drills, and many of the rotary drills now on the market.

The first Robbins drill was mounted on a Caterpillar D6 Tractor. It drilled a 9-in. blasthole and provided a 15-ft steel change. Later models of the drill, mounted on Caterpillar D8 Tractors, drill a 9-in. hole with a 25-ft steel change. A revolving rack which holds 5 steels makes steel changes easy.

Adapters are now provided for mounting the drill on non-Caterpillar crawler tractors.

Power to drive the rotary comes from the rear power takeoff of the tractor through a Fuller K8 or K11 transmission, with 4 speeds forward, 1 reverse.



Mounted on a Caterpillar D8

Through a chain drive, the transmission powers a right angle connection to a square shaft running the height of the drill unit. The square shaft powers a sliding gear box which rotates the drill steel at speeds between 25 and 120 RPM.

Down pressures as high as 30 tons on the drill bit are obtained by two 8-in. hydraulic cylinders operating off a 70 GPM Hydraulic two-stage pump driven from power take-off of the tractor. These hydraulic pistons operate a rack and pinion that raise and lower the drill pipe by two chain sprockets, providing the necessary down pressure on the bit. Also by means of hydraulic controls, three jacks can level the tractor for drilling.

A 600 cfm air compressor forces air into the drill pipe to blow chips and dust away from the drill bit. **The Robbins Machine & Mfg. Co., CE 12-126, Oneonta, Ala.**

EQUIPMENT MATERIALS and METHODS

(continued)

Earth-Boring Machine

A TRUCK-MOUNTED EARTH-BORING machine with hydraulic turntable base and swivel action that permits operation at any angle over a full 180-degree arc without having to move the truck itself is one of the latest additions to their Utility Division.

Hydraulic extension action also gives the earth borer an extra 22-in. "reach" within its operational radius. It is capable of digging holes from 9 to 36 in. in diam and up to 10-ft—in any soil and on any level.

Mobility of Highway's "swing-base" earth borer provides a number of key advantages over the conventional fixed-platform type that can operate in only one position, usually from the tail end of its truck carrier; in construction of utility lines or foundation footings along city streets or open highways, the swing base allows the boring head to dig from either side of the carrier. Traffic tieups or safety hazards that result when a truck is backed to the curb are eliminated; since its carrier does not have to be maneuvered to get the machine into operating position, the borer can function speedily and efficiently in cramped quarters that would be inaccessible to truck-mounted types with fixed platforms. The machine can be swung in a complete half-circle in nine seconds and series of holes can be dug at any angle within the machines operational arc without moving the truck. A leveling mechanism, attached to the boring head, permits it to bore in absolute vertical plumb even if the carrier is parked on a slope.

By attaching an integral winch and derrick apparatus to the machine, poles from 40 to 45-ft in length and 2000 to 2500 lb in weight can be lifted and set. **Highway Trailer Company, CE 12-127, Edgerton, Wis.**

Davis Cab

CAB PROTECTION FOR the operator of the Davis Model 185 Back-Hoe is now available at Davis Products dealers.

The lighthouse-type window, made of rugged, non-breakable and shatter-proof clear plastic, gives the operator full vision at all angles of operation. Side curtains and floors are easily removed for warm weather use.

The Davis Cab fits on the seat and footrest assembly so that it revolves with the boom. It is formed of flat steel for maximum strength, is covered with heavy, durable duck canvas and is easily installed. This model operates to either side or to the rear of the tractor. **Mid-Western Industries, Inc., CE 12-127, Wichita, Kansas.**

EQUIPMENT MATERIALS and METHODS

(continued)

Super Boom

THE LIMA TYPE 1250, a rugged, low-slung, air controlled machine available also as a shovel or dragline, is offered to supply the demand for super booms in the construction market. When equipped as a crane, with a standard 60-ft boom, it has a lifting capacity of 100-tons at a 13-ft radius.

The crane in the illustration, equipped with a 200-ft boom plus a 50-ft jib, is designed to handle steel erection and concrete pouring on multi-storied apartment and business buildings up to and including 24 floors.

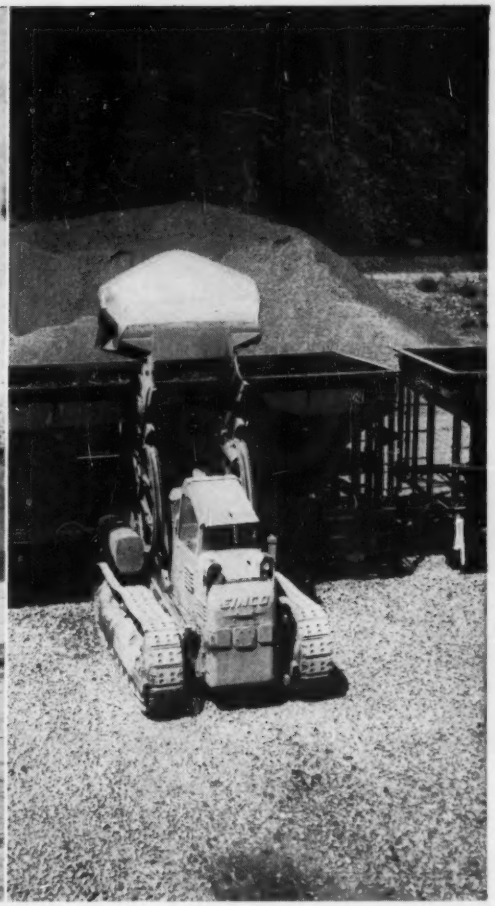
As a standard shovel, the 1250 is equipped with a 28-ft boom, 22-ft dipper handle and 3 cu yd bucket and a high lift shovel, with a 45-ft boom, 32-ft dipper handle and 2 1/2 cu yd bucket.

Features and available equipment include: independent propel, loading-lowering device, extra high speed hoist attachment, third drum, power reversing hoist

Lima Type 1250

drum, heavy duty and special light weight booms, light plants, two widths of crawlers, two lengths of crawlers, two widths of crawler treads, two types of rigid gantries, two types of folding gantries. The 1250 has a one-piece carbon steel cast rotating and truck base, fabricated steel machinery frames, machine-cut gears, telescopic boom stop with automatic shut-off, steering controlled by gear type jaw clutches, heat-treated alloy steel ground shafting and large diameter clutches and brakes.

An outstanding feature is the design which permits a knock-down for haulage into units of less than 60,000 lb. Counterweight segments are readily removable. The gantry may be folded to a height of 12-ft-7 1/4-in. Diesel, gasoline and electric power plants with torque converters are available. **Baldwin-Lima-Hamilton Corp., CE 12-128. Construction Equipment Division, Lima, Ohio.**



EIMCO 105 – A LOADING CYCLE TIME SAVER

Working for a major railway firm in track maintenance operations, an Eimco 105 Tractor-Excavator provides extra-production capacity in loading out a 50-cubic-yard car every eight minutes. The Eimco loads 125 cubic yards more every hour than the machine it replaced.

For this steady job, the 105 is equipped with the high discharge rocker arms and bucket.

The Eimco replaced a 1½ yard shovel that was loading five cars an hour. Before the operator mastered extra-production features of the 105, it was loading six cars an hour. With an experienced operator, it now averages 7½ cars an hour.

Previously, one of two dozers pushing gravel toward the loading edge, came off the 50-foot-high pile to push loaded cars to the switch. The 105 now accomplishes this task and the shovel and one dozer have been released to work elsewhere.

How does the 1½ yard Eimco, with an initial investment that is nearly one-third less, take on extra duty and still increase production?

The answer is in the 105's ability to save time during every loading cycle. With one hand, the operator pushes two, easy-to-reach levers and the Eimco moves in for a load. Powerful crowding actions fills the bucket quickly. He pulls the levers and the 105 reverses to the haulage car while the loaded bucket is elevating in an arc.

When the Eimco is in dumping position, the bucket is in discharge position. There's no lost motion between loading and discharge.

Independent track control permits the 105 to maneuver fast and sharp—another time saver.

And shifting between high and low speeds—forward and reverse—is done under maximum loads at anytime without injury to the transmission. You don't have to stop to shift—or hesitate until the tachometer needle falls below the recommended RPM reading.

The best way to get an idea how the Eimco 105 will increase your production is to watch it perform. You can arrange this today by writing Eimco.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Pittsburgh, Pa. Seattle, Wash.
Cleveland, Ohio Houston, Tex. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

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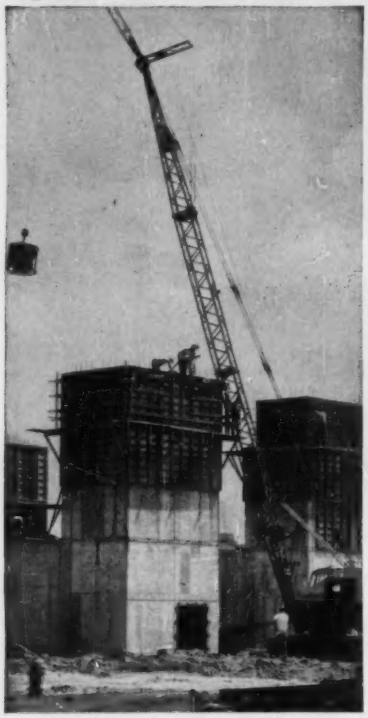
Symons FIELD REPORT...



SYMONS FORMS USED ON TWA TEST CELLS ...

Five aircraft engine test cells, with exhaust and intake stacks 45 feet high, are being erected at Trans World Airlines' overhaul base at Mid-Continent International Airport, Kansas City, Mo.—the first cells of their kind in the United States.

These cells are on a concrete base, and 12,500 square feet of Symons Forms with Steel Cross Members were used for the 55,000 square feet of concrete forming required. Sharp Brothers Contracting Company, Kansas City was the general contractor.

TWA test cells are just one of many commercial, industrial, institutional and public works construction jobs for which Symons Forms are adaptable. Symons engineering staff gives complete service on the details of all forming jobs. Our salesmen are field-trained to give practical advice on form erection, pouring and stripping methods.

Symons Forms, Shores and Column Clamps may be rented with purchase option, rentals to apply on purchase price. Symons Clamp & Mfg. Co., 4291 Diversey Ave., Dept. M-6, Chicago 39, Ill.

In this unusual stripping procedure, panels are being removed by a worker seated in a bosun's chair suspended from a crane boom.

For More Information on FORMS—CLAMPS—SHORES. Write for Literature

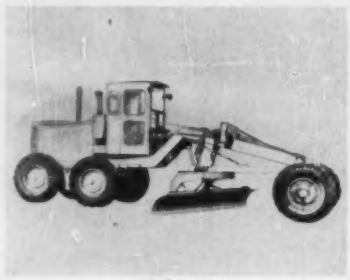
EQUIPMENT MATERIALS and METHODS

(continued)

Moldboard Shock

A NEW PRODUCT IN THE heavy equipment field, the Over-Lowe "Hi-Speed" Moldboard Shock, has now been designed and developed. These units fit most standard graders and through a resultant "floating blade" enables the grader operator to maintain road speeds up to 12 miles per hour, four times the average maintenance speed.

While its primary function is to decrease road maintenance time, the new shocks enable owner and operator to realize other grader economies. According to the manufacturer some of these improvements are: almost complete elimination of high speed grader bounce,



Hi-Speed

since operators no longer have to "fight the controls"; ability to plow snow off gravel and hard surface roads without damaging road surfaces; the maintenance of shoulders on asphalt and concrete roads without damage; increased grader life since, by reducing wear and tear, you reduce downtime, and increased blade life, because the blade "floats" when shocks are used and cannot damage road or pavement. **Over-Lowe Co., CE-12-130, P. O. Box 2879, Denver 1, Colorado.**

New Ties Cut Costs in Low Wall Forming

INTRODUCTION OF TWO NEW base ties that eliminate the need for nails and save on labor in low wall grade beam forming has been announced. One tie is designed for use with its wood forms and the other for its magnesium and steel frame forms.

Ties plus wedges are all that is required to secure forms at the top and bottom. Under the old method, nailed cleats were used to hold forms in place on top and band iron on the bottom. The ties, by eliminating the use of nails, materially increase the life of forms. There is no break-off point. The top ties can be reused indefinitely and the bottom ties are below grade. **Symons Clamp Mfg. Co., CE 12-130, 4249 Diversey Ave., Chicago 39, Ill.**

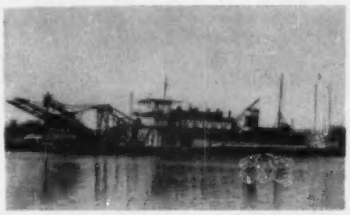
EQUIPMENT MATERIALS and METHODS

(continued)

Hydraulic River Dredge

THE LATEST ADVANCE IN hydraulic dredge design, the "M. O. P. DH-6 ADENAVI," built by an internationally prominent dredge building firm, for the Republic of Columbia, this new self-propelled hydraulic river dredge features a number of unique and highly individual design characteristics. Chief among these is its adaptation for the use as both a cutterhead and dustpan dredge, first of its type successfully developed.

The mammoth floating excavator with overall hull dimensions of 200-ft long, 44-ft wide, and 7½-ft deep is self-propelled by dual propulsion motors which can



achieve a speed of approximately 8 knots when moving from one dredge operation to another.

It has horsepower totaling 2,000 and a rated output of approximately 2,000 cu yd per hour maximum of dredged material when used as a dustpan dredge. As a cutterhead dredge, it has a rated output of approximately 850 cu yd of dredged material per hour, maximum.

The dredge will be used for the development and maintenance of the Magdalena River, chief navigational artery for that South American republic. **Ellicott Machine Corporation, CE 12-131, 1611 Bush Street, Baltimore 30, Md.**

Emery Aggregate

PLANT CONSTRUCTION HISTORY was made this summer when over a million square feet of surface hardened flooring was laid for the new Rosemead Assembly plant of the Ford Motor Co.

To meet heavy duty, high traffic requirements, an emery aggregate hardener was worked into the surface of a still-wet, regular steel-reinforced six-inch concrete base. The base was designed to have a 3000 psi compressive strength. Called Emeri-Topcrete, the surface hardener is a special mixture of type "SH" Cortland Emery and a good grade of Portland Cement. The Cortland Emery is rich in aluminum oxide for hardness and in iron oxide for toughness and non-brittleness. When properly mixed and applied, the surface hardener has a diamond-like resistance to abrasion and withstands shock. It also insures lateral stability.

(*Continued on page 132*)

EQUIPMENT MATERIALS and METHODS

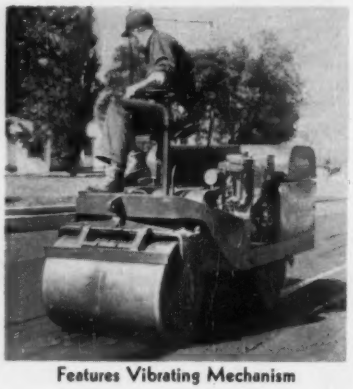
(continued)

At the rate of 90-lb of hardener per square foot of slab, the hardener is worked into the concrete with wooden floats which are manipulated by hand. After the concrete slab, with its worked-in surface hardener has set for half an hour, the top is gone over with circular mechanical finishing machines. **Walter Maquire Co., Inc., CE 12-131 & 132, New York, N. Y.**

Power Roller

A NEW AND SOMEWHAT revolutionary power roller using vibration instead of static weight has recently been introduced. Weighing $1^1/_2$ tons, it will produce the same compaction density as deadweight rollers weighing 8–10 tons.

The vibrating mechanism, consisting of eccentrically weighted parallel shafts 36-in. long mounted on self-aligning bearings,



Features Vibrating Mechanism

produces a dynamic vertical thrust of 2936-lb 2400 times per minute. Ground vibrations are controlled in direction and can be felt within a variable radius of 24-ft. Chassis vibration has been 98% eliminated by rubber and spring mountings. **Rolcor Industries, CE 12-132, Minneapolis 3, Minn.**

Durajoint

DESIGNED FOR USE BETWEEN adjacent sections of plain, reinforced or precast concrete structures such as tanks, channels, tunnels, culverts, dams, swimming pools, and building structures of all types, Durajoint, according to its manufacturers, replaces metallic strips and rubber or bituminous materials generally used. It is specifically compounded and extruded from a Theomo-Plastic material (Polyvinylchloride-PVC) suitably plasticized and supplied in long flexible coils. **W. R. Meadows, Inc., CE 12-132, 7 Kimball St., Elgin, Ill.**

Literature Available

INDUSTRIAL ENGINES—A new brochure describing fully the 1956 line of Jeep four-cylinder industrial engines and power units has been issued. Suggested applications for engines and units are included. Complete tables of engine speeds in relation to torques and horsepower ratings in the 20–55 hp range reveal the flexibility of today's Jeep engines, both the improved L-Head model L-4, and the F-Head model F-4, said to be the most efficient and economical "four" available to industry. Described also are the special features incorporated in Jeep industrial engines. **Industrial Engine Department, Willys Motors, Inc., CE 12-133, Toledo, Ohio.**

WIRE ROPE—An information packed bulletin No. DH-128D has just been issued. It covers more than 120 different types of wire ropes used in construction by bulldozers, scrapers, derricks, dragline excavators, shovels and winches; in conveyors by button, disc, can and hook units; in cranes by truck or crawler, in dredges for anchor cables, hoist lines, etc. Each recommendation covers such points as rope diameters, construction, preforming, lay, grade and core. **American Chain & Cable Co. Inc., CE 12-133, 929 Connecticut Ave., Bridgeport 2, Conn.**

BECKMAN pH EQUIPMENT—How this equipment is helping extend the life of the Cincinnati, Ohio, sewerage system and scientifically detect explosive sewer gases is described in the two latest Beckman Application Data Sheets. By keeping a check of the pH of waste discharges through use of the pH equipment mounted on a specially constructed trailer the Cincinnati Sewage Disposal Section has obtained permanent and accurate records of waste discharges. Most important, the sewerage system life has been extended. Ask for Application Data Sheets W-54-W and DK-56-W. **Beckman Division, Beckman Instruments, Inc., CE 12-133, Fullerton, Calif.**

WIRE ROPE—Latest information on Tiger Brand Wire Rope is now offered in a colorful, well-illustrated Catalog #6510. Various types of wire rope along with their many uses and directions for their care are thoroughly explained. **American Steel & Wire, Division of United States Steel, CE 12-133, Rockefeller Bldg., Cleveland, Ohio.**

SINGLE RAIL TRANSPORT—Information about this new powered unit with hopper is being offered in the form of a press kit. It contains literature, giving a complete description with illustrations of the Railporter together with news releases and photos. **Chain Belt Company, CE 12-133, Milwaukee 1, Wis.**

From the MANUFACTURERS

LARGE AIR FORCE PRESS: Designed, built and installed by Loewy-Hydropress Division of the Baldwin-Lima-Hamilton Corp. the 126-ft press can exert pressures up to 8,100 tons. The new installation is producing vital structural members for the B-52 and other advanced aircraft and missiles... **GLASS CLAD BUILDING:** At the American Hardware Mutual Insurance Co.'s new 4-million dollar office building, Minneapolis, windows are of insulating glass and spandrels are of Pittsburgh Plate Glass' new colored Spandrelite. A unique cellular glass insulation, Foamglas, was used in 2-in. thickness behind the Spandrelite; on the roof and promenade deck and behind the marble column facings... **EXPANSION TRENDS:** The increasingly active part being taken by Bechtel Corp. of San Francisco in the rapid industrial growth of the Gulf Coast has led to the establishment of a new branch office in Houston, Texas. This will provide regional headquarters for service to clients interested in petroleum, petrochemical, and natural gas... Contract for the construction of a Transite asbestos-cement pipe plant at Denison, Texas, the 7th in Johns-Manville Corp.'s expansion program has been let to the Austin Co. of Cleveland and Houston ...A new corporation, American Hoist Pacific Co. in Seattle has been formed primarily to produce special custom engineered heavy materials handling equipment not normally offered by American Hoist & Derrick, St. Paul... The Detroit Diesel Engine Division of General Motors has expanded its administrative sales and sales and service facilities in six key cities: New York, Atlanta, Detroit, Chicago, Dallas and San Francisco... **GIANT CAP SCREWS:** Designed for the supersonic nozzle assembly of the largest wind tunnel in U. S., fifty giant hexagonal socket-head cap screws, $4\frac{1}{2}$-in. in dia. and having a combined weight of two tons, are being made by the Cleveland Cap Screw Co., Cleveland, Ohio... **MERGER:** The Koehring Co., Milwaukee, will acquire the Buffalo-Springfield Roller Co., effective Dec. 1st. Buffalo-Springfield makes asphalt finishing machines, road rollers and sole compaction equipment while Koehring manufactures concrete finishing and paving equipment, etc... **APPOINTMENTS:** Albert L. Love, Jr., Texas engineer has been assigned to the post of district engineer for the new Asphalt Institute office in Sante Fe, New Mexico... W. J. Klein has been appointed Vice President and W. L. Voegeli, General Sales Manager of the Tractor Group (Farm Equipment, Construction Machinery and Buda) of Allis-Chalmers Mfg. Co., Milwaukee, Wisc.... Peter Lewis, in his new position as Supervisor, Industrial Truck Sales Training, will be responsible for the development of training programs and material for Hyster's several hundred dealer salesmen.

PROCEEDINGS AVAILABLE

For instructions and Key to Abbreviations, see next page. Each member is entitled to 100 different "Proceedings Papers" yearly, ordered from these pages, plus all papers of the Technical Divisions in which he registers. The latter papers will be mailed automatically. To register, mail the enrollment form on page 137 to Society Headquarters. Discussion of a paper will be received during the four full months following the month of issue.

October

1088. New Developments in Septic Tank Systems, by John E. Kiker, Jr. (SA) During the past few years there have been some important changes in the design criteria for septic tanks and subsurface sewage disposal systems. These changes are set forth and evaluated.

1089. Preliminary Studies on Complete Anaerobic Sewage Treatment, by J. B. Coulter, S. Soneda, and M. B. Ettinger. (SA) Laboratory studies are described for the development of anaerobic contact sewage treatment system for use in small subdivisions which produces an effluent low in B.O.D. and suspended solids.

1090. The Highway Spiral as a Centerline for Structures, by Paul Hartman. (HW) This paper presents a method for computing the geometry of a structure with a spiral centerline. The method is simple and precise enough for steel work. The amount of computation is no greater than that required for the multicentered curve which customarily replaces a spiral on a structure.

1091. Discussions of Proceedings Papers 817, 818, 945, 1030. (EM) Chong-Hung Zee, Dean F. Peterson, and Robert O. Bock closure to 817. Daniel Frederick closure to 818. E. Silberman, N. N. Ambraseys on 945. G. W. Housner on 1030.

1092. Discussions of Proceedings Papers 714, 745, 747, 840, 953, 1006. (HY) J. J. Dronkers and J. C. Schonfeld closure to 714. E. W. Lane closure to 745. M. B. McPherson and H. S. Strausser closure to 747. Herbert M. Corn closure to 840. Arthur I. McCutchan, Sam Shulits on 953. Achille Lazard on 1006.

1093. Discussions of Proceedings Papers 703, 783. (HW) Corrections to 703. C. J. Posey closure to 783.

1094. Discussions of Proceedings Papers 696, 742, 959. (PO) M. Rocha, J. Laginha Serafim, A. F. da Silveira, and J. M. Ressurreição Neto closure to 696. T. C. Powers closure to 742. Ross M. Riegel on 742. G. S. Sarkaria, George E. Goodall on 959.

1095. Discussions of Proceedings Papers 757, 862, 866, 934, 940, 941, 1026. (SM) Horace A. Johnson closure to 757. C. Y. Li closure to 862. E. de Beer and A. Martens on 866. G. A. Leonards, John A. Focht, Jr., E. J. Zegarra, K. B. Hirashima on 934. L. A. Palmer, David A. Hopkins on 940. John V. Spielman, Nicols N. Ambraseys on 941. A. A. Eremin on 1028.

November

1096. Internal Ties in Slope Deflection and Moment Distribution, by Morris Ojalvo. (ST) This paper outlines a procedure which can be used in the slope deflection and moment distribution methods of analysis when the joints of a rigid frame are free to translate; this procedure makes use of imaginary internal ties. In moment distributions these ties may be considered as the restraints which prevent joint translation during the balancing of the moments. The procedure becomes increasingly useful for more complicated structures and does not complicate analysis of simpler structures. The versatility of moment distribution and slope deflection is retained or enhanced.

1097. Influence Lines for Circular Ring Redundants, by Henry M. Lummis. (ST) The engineer is frequently called upon to analyze circular rings for maximum bending moments, shear, and thrust. The influence lines presented with this paper obviate the necessity of resorting to indeterminate analysis of formulas for the solution, and the ring can be analyzed statically much the same as a simple beam.

1098. Earthquake Stresses in Building Floors, by Charles S. Glazbrook. (ST) The paper presents a method of approach to the analysis of stresses in building floors, which must distribute earth-shock loads coming onto them from above to the resisting elements below the floors.

1099. Ultimate Strength Design Under 1956 Building Code, by Raymond C. Reese. (ST) This paper shows how ultimate strength design is recognized for the first time in *Building Code Requirements for reinforced Concrete* (ACI 318-56), explains that this is ultimate strength design, not limit design (moments being obtained by elastic-frame analysis), shows the need for controlling shallow sections by deflection calculations, and points out that ultimate strength procedures are easier to apply and give more realistic results than working stress formulas.

1100. The Painting of Structural Steel, by E. J. Ruble. (ST) A review of research being conducted on the painting of steel structures is presented. The contents and use of the Painting Manual prepared by the Steel Structures Painting Council is discussed. Included is a description of the many tests being conducted by the Council on actual structures to determine the best methods of protecting the steel against severe cor-

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rosive conditions, such as brine drippings from refrigerator cars.

1101. Analysis of Ribbed Domes with Polygonal Rings, by Tsze-Sheng Shih. (ST) This paper presents methods of analysis of rigidly connected ribbed domes. Under a fully symmetrical loading, the dome is analyzed exactly by direct application of Castigliano's theorem. For antisymmetrical loads and symmetrical loads on two opposite ribs, auxiliary force systems and finite trigonometric series are used. By combining the latter two conditions, a solution for general loading is obtained.

1102. The Peoria Recharge Pit: Its Development and Results, by Max Suter. (IR) Research on artificial recharge was done in Peoria, Illinois, by the State Water Survey to find methods for overcoming the losses in ground-water storage due to overpumpage. A method was found to obtain the high rate of inflow from 23 to 27 mgd per acre. Many types of hydrologic, chemical, and bacteriological observations were made; some of the relationships found cannot yet be explained.

1103. "Safe Yield" in Ground-Water Development, Reality or Illusion?" by Raphael G. Kazmann. (IR) Definitions of "safe yield" are critically examined and found inadequate. The effects of embodying such a term in laws controlling the utilization of ground water are noted. An alternate, more feasible approach to the problem of ground-water control, based on the functional utilization of aquifers, is proposed.

1104. Evaporation from Free Water Surfaces at High Altitudes, by Harry F. Blaney. (IR) In the western United States, evaporation losses from reservoirs and lakes at high altitudes are important as an element affecting the net water supply available for irrigation crops, production of power, and municipal and industrial purposes. Except in unusual instances, evaporation cannot be measured directly from large water areas. Thus, it is common practice to measure evaporation from pans and use coefficients to reduce pan evaporation to lake evaporation. At high altitudes it is seldom possible to measure evaporation during the winter months because the water in the pans freezes. This paper presents data on evaporation in several western states and develops a method of estimating monthly evaporation for the entire year from temperature and other data.

1105. Irrigation Requirements Based on Climatic Data, by George H. Hargreaves. (IR) This paper shows the limitations of present methods of using climatic data in the computation of consumptive use and irrigation requirements. Water evaporation is considered as a physical process. Physical laws, climatic data, and theoretical considerations are used in deriving new equations for determining consumptive use or evapo-transpiration potential for any set of climatic conditions. A formula, based on use of evapo-transpiration potentials, is developed for transferring consumptive-use data from one set of climatic conditions to another. Climatic regions for the United States are described and use of consumptive-use data in computing of consumptive use for any given set of climatic and cropping conditions.

1106. Simplified Analysis of Rigid Frames, by Robert M. Barnoff. (ST) A procedure to reduce the time required to analyze rigid frames is presented in this paper. Formulas for balanced moments at the joints of four types of rigid frames are plotted on diagrams in order to simplify the numerical computations.

1107. Cable Friction in Post-Tensioning, by T. Y. Lin. (ST) The sources of frictional loss of prestress are discussed; data for the coefficients of friction under various conditions are presented; and methods for measuring and for reducing frictional losses are described.

1108. Effect of Bearing Ratio on Static Strength of Riveted Joints, by Jonathan Jones. (ST) This paper offers evidence that, in riveted joints of usual structural proportions subjected to substantially static loads, the joint strength will not be reduced if the ratio of rivet-bearing stress to axial or shearing stress is increased above that sanctioned by most specifications for steel buildings and bridges.

1109. Airport and City Planning, by Leigh Fisher. (AT) The author, studying the thesis that there is insufficient correlation between planning for airports and regional development planning, analyzes the specific factors which should be considered to achieve better integration of the airport with the community it serves. Ground transportation, airport-to-community distance, approach zoning, noise nuisance, and land use are some of the factors considered.

1110. Discussions of Proceedings Papers 720, 987. (AT) Robert Horonjeff and John Hugh Jones closure to 720. Corrections to 987.

1111. Discussions of Proceedings Papers 705, 706, 728, 788, 884, 961. (IR) Howard T. Critchlow closure to 705. Robert O. Thomas closure to 706. A. R. Robinson and Carl Rohwer closure to 728. M. Gamal Mostafa closure to 788. D. M. Forester on 884. Frederick L. Hotes, Wendell E. Johnson and Charles A. Cocks, Eugene W. Weber on 961.

1112. Discussions of Proceedings Papers 680, 735, 829, 914, 916, 917, 920, 973, 1019. (ST) Corrections to 680. Corrections to 735. Ephraim G. Hirsch and E. P. Popov closure to 829. Howard H. Mullins on 914. Corrections to 916. Leonardo Zeevaert closure to 917. R. B. Matthiesen and R. L. Moore on 920. R. K. L. Wen on 973. Cevdet Z. Erzen on 1019. Corrections to 1019.

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